THE OHIO JOURNAL OF SCIENCE

VOL. 57 SEPTEMBER, 1957 NO. 5

FUSULINIDS FROM THE PENNSYLVANIAN ROCKS OF OHIO

PAULINE SMYTH

The Ohio Geological Survey, Columbus 10, Ohio

INTRODUCTION

The Fusulinidae are a family of Foraminifera whose shells are present in late Mississippian, Pennsylvanian, and Permian marine rocks. They are large enough to be detected in the field and small enough to be identified in cores and cuttings. Not only are genera and species of this family widely distributed, but their definite and rapid evolution makes them good index fossils within their range.

Although several authors (Stout, 1918, 1927; Condit, 1912; Conrey, 1921) mentioned the occurrence of fusulinids in Ohio, and Morningstar (1922) described two species, the names used in these publications are now obsolete. Thompson (1936) described and illustrated six species and one variety according to modern classification in his paper on fusulinids in Ohio. The present writer gave a brief review of work in Ohio in 1951, and has made several small contributions since that time in unpublished masters' theses and doctoral dissertations (Blake, 1952; Teflian, 1952; Gray, 1954; Multer, 1955).

It is the purpose of this paper to report the progress which has been made in the study of Ohio fusulinids from 1951 to the present time, and to make available to Pennsylvanian stratigraphers in Ohio information which might aid them in identifying certain marine horizons both in the field and in the laboratory. Collections of fusulinids have been made from 117 localities, but there are many more known localities and work will continue.

No fusulinids have been reported from Mississippian rocks in Ohio. The Permian rocks of the State do not contain marine faunas. Fusulinids do occur, however, in the Pennsylvanian rocks of southeastern and eastern Ohio, which consist of shales, sandstones, clays, limestones, and coals in cyclic sequences. When fusulinids are present, they are in the marine limestone or in shale associated with it.

Fusulinids have been reported in 12 different marine limestones of the Pennsylvanian rocks of eastern Ohio. They are abundant in the Lower Mercer and Upper Mercer limestones of Pottsville age, the Putnam Hill and Vanport limestones of Allegheny age, and the Cambridge and Ames limestones of Conemaugh age. They are scarce in the Boggs, Zaleski, Hamden, Brush Creek, Portersville, and Gaysport marine members. Except for the Brush Creek, these last mentioned limestones are so limited in extent that the paucity of fusulinids may be due to the limited exposures of the units.

Fusulinids can be very useful in identifying certain members in the Pennsylvanian series of Ohio. It is necessary to grind thin sections of individual specimens in order to make positive species identification, but the different genera which are known in Ohio can be distinguished in the field with a hand lens. The genus

Fusulinella is found in rocks of Pottsville age, *Fusulina* and *Wedekindellina* in Allegheny rocks, and *Triticites* in Conemaugh rocks (fig. 1).

FUSULINID ZONES

Fusulinella iowensis and *F. iowensis* var. *stouti* are present in the Boggs, Lower Mercer, and Upper Mercer limestones, all of Pottsville age. These units cannot be distinguished from each other on the basis of fusulinids.

Fusulina leei is the only species which has been found in the Putnam Hill limestone. It closely resembles *F. carmani* of the Vanport limestone. The two species cannot be distinguished in the field. *Wedekindellina euthysepta* is associated with *Fusulina carmani* in the Vanport limestone and flint in about one half of the outcrops investigated and it has never been reported in the Putnam Hill limestone. Its slim pointed shape is easy to recognize and it serves to distinguish the Vanport horizon. The author has not found any fusulinid specimens in the Zaleski black flint although Morningstar (1922) reported them present. One specimen belonging to the genus *Fusulina* has been found in the Hamden Limestone; it is a little larger and more obese than *F. carmani*.

The author has examined several exposures of Brush Creek limestone without finding any fusulinids. Thompson (1936) describes *Triticites ohioensis* from the Brush Creek of Gallia County, and Blake collected some of the same species in two other places in Gallia County (localities 14 and 15).

The Cambridge limestone is a coquina of fusulinid shells in some exposures in southern and east-central Ohio. These shells are *Triticites ohioensis*, the same species which is known from the Brush Creek limestone and possibly from the Portersville horizon. No fusulinids have been reported from the Cambridge limestone northeast of Muskingum and Guernsey counties.

Triticites skinneri and *T. cullomensis* are the species known from the Ames limestone. They are both somewhat shorter and more obese than *T. ohioensis*. Differentiation is possible in the field. *T. skinneri* is known from one outcrop of the Gaysport limestone in Athens County.

No fusulinids have been found in the Skelley limestone, which is stratigraphically the highest member bearing a marine fauna in this state.

FOSSILIFEROUS BEDS

Boggs Member

The Boggs member of the Pottsville formation is the oldest marine horizon in which fusulinids have been found in Ohio. In southern Ohio the Boggs member consists of iron ore and some fossils have been found in dark shales associated with the ore (Morningstar, 1922, p. 37, 38). In a number of places in Muskingum County a hard limestone which contains marine fossils is developed at the Boggs horizon. The author found *Fusulinella iowensis* sparingly present in this limestone in Blunt Run, Muskingum County (loc. 28) and Thompson (1936) reported *F. iowensis* var. *stouti* from the same locality. *F. iowensis* is present in an outcrop of Boggs limestone in Wayne Township, Tuscarawas County (loc. 60).

Lower Mercer Member

The Lower Mercer fossiliferous limestone and shale can be traced across southeastern Ohio from Lawrence County in the south to Mahoning County in the northeast. It appears in all the counties where it might be expected and it is everywhere fossiliferous. Morningstar (1922) does not list fusulinids among the fossils found in the Lower Mercer limestone anywhere south of Muskingum County. The author has examined a few outcrops of Lower Mercer limestone in southern Ohio without finding fusulinids. In Muskingum County and northeastward fusulinids have been found in more than half of the outcrops examined. They are very

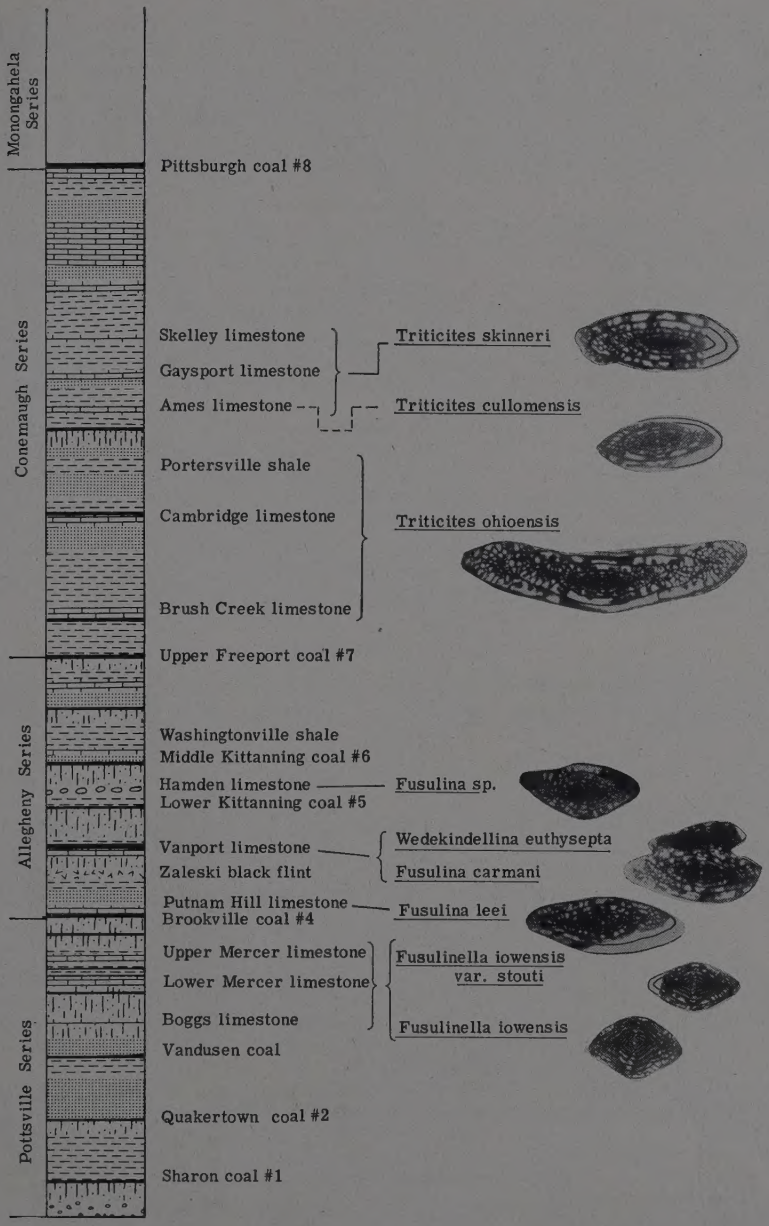


FIGURE 1

Stratigraphic Distribution of Fusulinids in Pennsylvanian Rocks of Ohio

abundant in some outcrops in Muskingum, Licking, and Coshocton counties (localities 31, 73, and 115). They are less abundant to the north and east but one specimen was found near the Pennsylvania border in Columbiana County (loc. 109).

Fusulinella iowensis was present in all the exposures of Lower Mercer limestone in which any fusulinids were found. *F. iowensis* var. *stouti* is associated with it at localities 31, 4, and 73 in Licking and Muskingum counties, and Thompson (1936, p. 677) reported the variety in Muskingum Township, Muskingum County.

Upper Mercer Member

Almost as continuous as the Lower Mercer limestone is the Upper Mercer limestone which lies from 15 to 50 feet higher. In southern Ohio this horizon is represented in most exposures by fossiliferous iron ore. In central and northeastern Ohio dark limestone and flint are characteristic. Because some phases of the Upper Mercer resemble the Lower Mercer, the two units are difficult to distinguish from each other unless both are present. So far no distinguishing fusulinid features have been found. *Fusulinella iowensis* and *F. iowensis* var. *stouti* are present in both members.

Up to the present time the author has made no collections from the Upper Mercer in southern Ohio. The southernmost locality investigated is number 47 in Hocking County where a very few specimens of *Fusulinella iowensis* were found in the black flint. Morningstar (1922) does not report any fusulinids in the Upper Mercer south of Clayton Township, Perry County. Fusulinids are present in most of the outcrops investigated in central and northeastern Ohio. They are abundant at localities 65 and 77 in Tuscarawas County. In the black flint phase of this member white fusulinids are conspicuous, but it is impossible to make satisfactory thin sections from this material.

Putnam Hill Member

The Putnam Hill limestone, which is the lowest marine horizon in the Allegheny series, is a gray limestone several feet thick in central Ohio. The type locality is at Putnam Hill in Zanesville, Muskingum County. The limestone thins from the type area, both to the south and to the northeast and is wanting in Lawrence and Scioto counties in the south and Mahoning and Columbiana counties in the northeast.

Fusulina leei is the only species of fusulinid which has been found in the Putnam Hill limestone. It is abundant at localities 1 and 54 in southern Coshocton County and also at localities 45 and 62 in Wayne and Stark counties respectively. It is less abundant to rare in 24 other localities from which the author has collections.

Zaleski Member

In southern Vinton and northern Jackson counties a marine horizon named the Zaleski member (Stout, 1927, p. 181) is developed in the interval between the Putnam Hill and Vanport members. This horizon, which is referred to as the Black Flint member by Morningstar (1922), consists chiefly of dark flint and siliceous limestone, bearing a marine fauna.

Morningstar (1922, p. 133, 134) found some specimens of fusulinids in this member but these specimens have been lost and the author was not able to find any in the field.

Vanport Member

In 1846 a French scientist, E. de Verneuil, traveling in the United States noted fusulinids in the buhrstone of Ohio. In his letter to the American Journal of Science he expressed surprise at finding this fossil, which was common in Russia, in this place half way around the world. The buhrstone to which he referred

was the Vanport member of the Allegheny series, and fusulinids were very likely *Fusulina carmani*. This is one of the earliest references to fusulinids in America.

The Vanport limestone is well developed in northeastern Ohio and southern Ohio but its occurrence across the middle part of the state is spotty, in some places missing or represented by nodules of fossiliferous limestone or flint. In Hopewell townships of Licking and Muskingum counties the flint is up to 10 feet thick and continuous. It is responsible for the ten mile long feature known as Flint Ridge. Fusulinids are conspicuous fossils in the blocks of flint in this area. The flint is underlain by unfossiliferous limestone.

In southern Ohio this horizon is referred to as the Ferriferous limestone, because of its association with the Ferriferous ore which was the foundation of the iron industry in Ohio in the last century.

The fusulinid species which is most common in the Vanport member is *Fusulina carmani*. The cotypes for this species were collected near the eastern end of Flint Ridge. Associated with *F. carmani* in many places is the distinctive pencil-shaped *Wedekindellina euthysepta*. Where the latter genus is present the Vanport limestone can be easily distinguished from the Putnam Hill limestone in the field.

Hamden Member

The Hamden member of the Allegheny series is composed of iron ore in southern Ohio and nodular limestone and ore in central Ohio. The limestone, which is best developed in Muskingum County, lies above the Lower Kittanning coal and below or within the Oak Hill clay. Nodules of black, fossiliferous, dense limestone from this member lie along the road west of Dillon in Muskingum County (loc. 75). One specimen of a fusulinid was found in this material. It belongs to the genus *Fusulina* and is more highly developed than *F. carmani* of the Vanport horizon.

Washingtonville Member

In north-central and northeastern Ohio a fossiliferous dark shale, the Washingtonville member, occurs in the upper part of the Allegheny series. Lamborn (1930) lists a few fossils from this horizon in Jefferson County, but fusulinids have not been found in it.

Brush Creek Member

The lowest marine horizon in the Conemaugh series of Ohio is the Brush Creek limestone. Its outcrop is fairly continuous where it might be expected, and ordinarily consists of two beds of fossiliferous limestone separated by 20 to 30 feet of fossiliferous shale.

The author has spent very little time looking for fusulinids in the Brush Creek limestone. Condit (1912) does not list fusulinids among the fossils found in the Brush Creek. Thompson (1936) reports *Triticites ohioensis* in the Brush Creek of Gallia County and Oliver Blake found fusulinids in this bed in two other localities in Gallia County. Thin sections of Blake's material made by the author show *T. ohioensis*.

Cambridge Member

The Cambridge limestone, named for exposures at Cambridge in Guernsey County, Ohio, is variable in lithology and discontinuous in occurrence. No fusulinids have been reported among the fossils from outcrops of this unit in areas north and northeast of the type area. South and southwestward from Cambridge fusulinids have been reported in this limestone in every county where it crops out. In York Township, Morgan County (loc. 38) a coquina of fusulinid shells forms the top 8 inches of a two-foot limestone. *Triticites ohioensis*, the species which is found in the Cambridge limestone, is the longest species of fusulinid known in Ohio, the shells being about the size of a wheat grain. Cotypes for this species were collected in Gallia County (Thompson, 1936, p. 682).

Portersville Member

The Portersville member is a dark shale which contains a marine fauna and lies from 12 to 30 feet above the Cambridge limestone in central Ohio. Myron Sturgeon and William Merrill found fusulinids in limestone nodules at the Portersville horizon in sections 28, 29, and 30 in Alexander Township, Athens County. The author tentatively identified them as *Triticites ohioensis*.

Ames Member

Because of its distinctive lithology and fossil content and its wide spread distribution, the Ames limestone is an important horizon marker in the Conemaugh series. This coarsely crystalline, gray or greenish-gray limestone has been called the crinoidal limestone because of the abundance of crinoid fragments which it contains. The member is thin, nodular, or missing in parts of Lawrence and Gallia counties, but northward it is more continuous and forms a single bed one to three feet thick.

Fusulinids are abundant in the Ames limestone; *Triticites skinneri* occurs in central Ohio, and T. *cullomensis* in southern Ohio. The white fusulinid shells are conspicuous on weathered surfaces of the gray limestone. Fusulinids are less abundant northward, and have not been reported from this member in Guernsey, Harrison, and Carroll counties. The author found a few specimens of *T. skinneri* in a roadside outcrop in Madison Township, Columbiana County (loc. 108) and believes that further search will uncover specimens in areas where they are not now known.

Gaysport Member

In Muskingum, Morgan, and Athens counties the Gaysport limestone is an impure fossiliferous limestone which lies about 16 feet above the Ames limestone. *Triticites skinneri* was collected from the Gaysport horizon in Athens Township, Athens County (loc. 18). This is presently the only known occurrence of fusulinids in the Gaysport.

Skelley Member

The highest marine limestone of the Pennsylvanian series in Ohio is the Skelley limestone, a thin bed of variable composition. No fusulinids have been reported among the fossils of this unit.

DESCRIPTION OF SPECIES

Terms used in this paper follow Dunbar and Henbest. 1942.

Fusulinella iowensis Thompson, 1934

Figures 5, 6, 7, 10, and 11

Girtyina ventricosa Morningstar. 1922. Ohio Geol. Survey Bull. 25: 153, pl. 6, fig. 4. Upper Mercer limestone, central Ohio.

Fusulinella iowensis Thompson. 1934. Iowa Univ. Stud. Nat. Hist. 16: 296–297, pl. 20, figs. 28–30. Cherokee shale, 90 feet below Whitebreast coal, Davis County, Iowa.

Fusulinella iowensis Thompson. 1936. Jour. Paleont. 10: 675, pl. 90, figs. 12–16. Upper Mercer and Lower Mercer limestones, Muskingum County, Ohio.

Fusulinella iowensis has a small, almost spherical shell with bluntly pointed poles. The axis of coiling is straight; lateral slopes are straight or concave. The first and second whorls are spherical in shape; outer whorls have poles extended to blunt points. Mature specimens have 8 or 9 whorls with half lengths from 0.60 mm. to 1.00 mm. in the 6th whorl and form ratios from 1: 1.2 to 1: 1.7 in the same whorl. Average half length in the 8th whorl is 1.09 mm. with a form ratio of 1: 1.5.

The proloculum is small with an average inside diameter of 0.06 mm. Dimorphism is common in this species. The two forms are similar in external appearance. A microspheric specimen with its juvenarium is shown in figure 7.

The protheca is thin in all whorls. The epitheca is thick and massive, almost filling the chamber space in the inner whorls from the well developed chomata to the poles. In the outer whorls the chomata are almost as high as the chambers and about 3 times as wide as high. They are asymmetrical in shape, rising steeply from the tunnel and tapering towards the poles.

Septal count averages 10, 18, 20, 22, 27, 33, and 37 for the first seven whorls of 15 specimens. The septa are plane in inner whorls and near the equatorial part of all whorls. They have gentle undulations near the poles of outer whorls.

The tunnel is narrow and well defined. It is crooked in some specimens and straight in others. The tunnel angles vary from 10° to 30° with gradual increase from inner whorls outward and less than 10° difference from the first whorl to the last whorl in most shells.

TABLE 1

Measurements for Fusulinella iowensis *Thompson*

Whorl	Half length in mm.				Radius vector in mm.				Form ratio				Tunnel angle					Septal count		
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	5	6	7	8
1	0.08	0.09	0.08	0.12	0.06	0.07	0.05	0.12	1.3	1.3	1.6	1.0	—	19°	15°	15°	14	—	12	—
2	0.14	0.16	0.16	0.25	0.11	0.11	0.08	0.19	1.3	1.5	2.0	1.3	16°	14°	12°	10°	17	14	15	17
3	0.22	0.24	0.25	0.37	0.16	0.17	0.12	0.29	1.4	1.4	2.0	1.3	12°	14°	14°	10°	23	16	18	23
4	0.33	0.33	0.33	0.49	0.25	0.25	0.18	0.39	1.3	1.3	1.8	1.3	13°	12°	12°	12°	27	24	24	28
5	0.43	0.47	0.43	0.67	0.33	0.37	0.27	0.52	1.3	1.3	1.6	1.3	13°	14°	10°	16°	32	26	28	32
6	0.53	0.73	0.59	0.90	0.43	0.47	0.35	0.65	1.2	1.6	1.7	1.4	16°	15°	10°	11°	33	27	29	42
7	0.76	0.84	0.76	1.12	0.55	0.59	0.47	0.84	1.4	1.4	1.6	1.3	19°	16°	19°	11°	39	30	34±	41
8	0.96	0.96	0.96	1.57	0.69	0.73	0.59	1.00	1.4	1.3	1.6	1.6	—	12°	12°	—	—	34	38±	42±
9		1.22	1.10			0.88	0.71			1.4	1.5			—	—			34±		
	Diameter of inside of proloculum in mm.																			
	0.06	0.06	0.08	0.09													0.06	—	0.06	—

Specimen 1 is a microspheric specimen; specimen 2 is illustrated in figure 7; specimens 3, 4, and 8 are from the Upper Mercer limestone, the rest are from the Lower Mercer limestone.

Remarks.—*Fusulinella iowensis*, the smallest species of fusulinid found in Ohio, is easily recognized in the field by its small size and spherical shape. It is associated with *F. iowensis* var. *stouti* from which it can be distinguished by its smaller form ratio. It is widely distributed in the Pottsville limestones of central and northeastern Ohio and has been reported from as far west as New Mexico (Henbest and Read, 1944).

Distribution.—This species is abundant or present in many localities where the Lower Mercer limestone is exposed in east-central and northeastern Ohio. It is also widely found in the Upper Mercer limestone and black flint, and has been identified from the Boggs limestone and Muskingum and Tuscarawas counties. It has been reported in the Seville limestone of northwestern Illinois (Dunbar and Henbest, 1942), in the Cherokee shale, 90 feet below the Whitebreast coal, Davis and Jefferson counties, Iowa (Thompson, 1934), and possibly in the Madera limestone of Sandoval County, New Mexico (Henbest and Read, 1944).

Fusulinella iowensis var. stouti Thompson 1936

Figures 8 and 9

Fusulina secalica Morningstar. 1922. Ohio Geol. Survey Bull. 25: 153, pl. 6, fig. 3. Lower Mercer limestone, Upper Mercer limestone, and Zaleski black flint of Ohio.

Fusulinella iowensis var. *stouti* Thompson. 1936. Jour. Paleont. 10: 677, pl. 90, figs. 5–11. Boggs limestone, Lower Mercer limestone, and Upper Mercer limestone, Muskingum County, Ohio.

Fusulinella iowensis var. *stouti* Dunbar and Henbest. 1942. Illinois Geol. Survey Bull.

67: 95, pl. 3, figs. 7, 8, 9. Seville limestone, Fulton County, Illinois and possibly in Boskydell (?) marine zone, Pope County, Illinois.

The shell of this variety is small with inflated center section and bluntly pointed ends. The first three whorls are subspherical in shape but the outer whorls are more elongate. The lateral slopes are straight. A number of specimens are bluntly diamond-shaped from the 5th whorl outward.

The mature specimens have 7 whorls with half lengths from 0.82 to 1.47 mm. in the 7th whorl and form ratios of 1: 1.7 to 1: 2.2 in that whorl. Very few specimens which can be identified as this variety have as many as 8 whorls.

The proloculum is small with an average inside diameter of 0.06 mm. One specimen has a double proloculum (fig. 9). It is unusually elongate for this variety and its measurements have not been included in the averages given.

The walls are similar to *F. iowensis*; the protheca is thin and the epitheca thick and massive. In most specimens this secondary deposit extends from the chomata to the poles in all but the outer whorl. The chomata are asymmetrical in shape. They have a steep side toward the tunnel and merge into a long taper towards the poles. The chomata are more than one half as high as the chambers.

Septal count for one specimen was 9, 13, 16, 20, 24, and 32 for the first six whorls. Septa are plane across the middle and gently undulating in the polar areas.

TABLE 2

Measurements for Fusulinella iowensis *var.* stouti *Thompson*

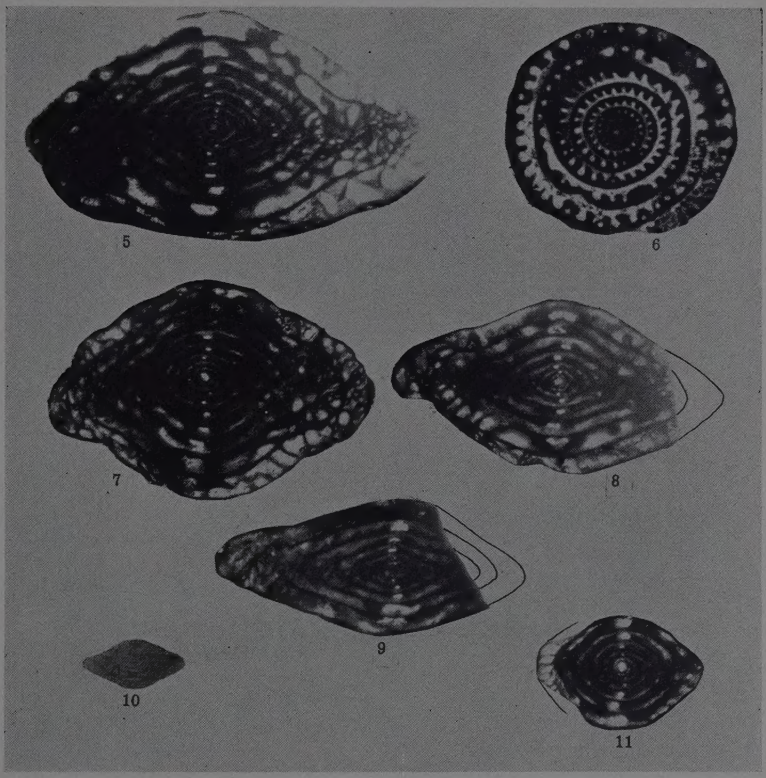
Whorl	Half length in mm.				Radius vector in mm.				Form ratio				Tunnel angle				Septal count
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	5
1	0.18	0.12	0.08	0.10	0.06	0.08	0.06	0.06	3.0	1.5	1.3	1.7	14°	13°	25°	28°	9
2	0.28	0.24	0.20	0.20	0.10	0.14	0.10	0.10	2.8	1.7	2.0	2.0	17°	14°	18°	20°	13
3	0.47	0.37	0.29	0.35	0.18	0.20	0.14	0.17	2.6	1.8	2.0	2.0	19°	15°	17°	16°	16
4	0.61	0.65	0.49	0.47	0.27	0.31	0.22	0.25	2.3	2.1	2.2	1.9	31°	18°	15°	18°	20
5	0.96	0.76	0.71	0.63	0.37	0.43	0.33	0.34	2.6	1.8	2.2	1.9	24°	22°	14°	20°	24
6	1.39	0.94	0.90	0.80	0.49	0.57	0.43	0.45	2.8	1.6	2.1	1.8	—	—	18°	25°	32
7		1.22	1.02			0.71	0.55			1.7	1.9			—	—		
	Diameter of inside of proloculum in mm.																
	double	0.06	0.05	0.04													—

Specimen 1 is the specimen with the double proloculum illustrated in figure 9; specimen 2 is illustrated in figure 8; all specimens from the Lower Mercer limestone.

The tunnel is narrow but rather crooked in most specimens. Tunnel angles vary from 10° to 26° in all specimens measured, but the range was less on individual ones.

Remarks.—This variety differs from *F. iowensis* in the form ratio. The form ratios in outer volutions are from 1: 1.71 to 1: 2.15 while in *F. iowensis* they exceed 1: 1.70 only in a few sections. In the ones examined *F. iowensis* var. *stouti* has fewer volutions than mature shells of *F. iowensis* and microspheric specimens are not as common. It is distinguished from *Fusulina leei* of the Putnam Hill limestone by smaller size, smaller form ratio, more massive chomata, and smaller proloculum.

Distribution.—The author has found *F. iowensis* var. *stouti* in the Lower Mercer limestone in localities 4 and 73 in Muskingum County, locality 31 in Licking County and locality 1 in Coshocton County. Thompson (1936) identified it in the Boggs, Lower Mercer, and Upper Mercer limestones of Muskingum County; it has also been reported in the Seville limestone of Fulton County, Illinois (Dunbar and Henbest, 1942) and the Madera limestone of Sandoval County, New Mexico (Henbest and Read, 1944).



EXPLANATION OF FIGURES IN PLATE I

All figures magnified ×20 except figure 10.

5. *Fusulinella iowensis* Thompson, axial section from Upper Mercer limestone, Wayne County, locality 67. O. S. U. No. 22240.
6. *Fusulinella iowensis* Thompson, sagittal section from Lower Mercer limestone, Mahoning County, locality 79. O. S. U. No. 22241.
7. *Fusulinella iowensis* Thompson, axial section from Lower Mercer (?) limestone, Portage County, locality 80. O. S. U. No. 22242.
8. *Fusulinella iowensis* var. *stouti* Thompson, axial section from Lower Mercer limestone, Muskingum County, locality 73. O. S. U. No. 22243.
9. *Fusulinella iowensis* var. *stouti* Thompson, axial section of unusually elongate specimen with a double proloculum from Lower Mercer limestone. Muskingum County, locality 73. O. S. U. No. 22244.
10. *Fusulinella iowensis* Thompson, free specimen from Lower Mercer limestone, Muskingum County, locality 4 (×7).
11. *Fusulinella iowensis* Thompson, axial section of immature specimen from Boggs limestone, Muskingum County, locality 28. O. S. U. No. 22245.

Fusulina leei Skinner 1931

Figures 17, 18, and 19

Fusulina sp. Stout. 1918. Ohio Geol. Survey Bull. 21: 129, 134. Putnam Hill limestone, Muskingum County, Ohio.

Fusulina secalica Conrey. 1921. Ohio Geol. Survey Bull. 24: 115. Putnam Hill limestone, Wayne County, Ohio.

Fusulina leei Skinner. 1931. Jour. Paleont. 5: 257, 258, pl. 30, figs. 4, 6. Cherokee shale, overlying Bluejacket sandstone, Mayes County, Oklahoma.

Fusulina leei Thompson. 1934. Iowa Univ. Stud. Nat. Hist. 16: 301–303, pl. 21, figs. 3, 7, 10, 18. Cherokee shale, 35 feet below the Whitebreast coal, Lucas and Monroe counties, Iowa.

Fusulina leei Thompson. 1935. Jour. Paleont. 9: 305, pl. 26, figs. 17–19. Upper part of Boggy formation, Pontotoc County, Oklahoma.

Fusulinella serotina Thompson. 1936. Jour. Paleont. 10: 677, 678, pl. 90, figs. 1–4; pl. 91, fig. 9. Putnam Hill limestone, Muskingum County, Ohio.

Fusulina leei Dunbar and Henbest. 1942. Illinois Geol. Survey Bull. 67: 109–111, pl. 5, figs. 1–8; pl. 6, figs. 1–10. Curlew limestone, Saline and Gallatin counties, Illinois.

Fusulina leei Alexander. 1954. Oklahoma Geol. Survey Circular 31: 33–34, pl. 2, figs. 19–20. Lower Inola limestone, Mayes County, Oklahoma.

TABLE 3

Measurements for Fusulina leei *Skinner*

Whorl	Half length in mm.				Radius vector in mm.				Form ratio				Tunnel angle				Septal count			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	5	6	7	8
1	0.20	0.22	0.12	0.16	0.10	0.11	0.09	0.10	2.0	2.0	1.3	1.6	25°	19°	18°	18°	11	11	11	9
2	0.38	0.41	0.20	0.33	0.15	0.19	0.15	0.16	2.5	2.2	1.3	2.0	22°	23°	30°	23°	14	14	19	14
3	0.53	0.61	0.35	0.61	0.23	0.29	0.25	0.24	2.2	2.1	1.4	2.5	20°	23°	30°	24°	18	16	21	17
4	0.73	1.18	0.71	0.86	0.33	0.41	0.37	0.33	2.2	2.9	1.9	2.6	27°	23°	28°	32°	18	17	21	20
5	1.22	1.59	1.18	1.12	0.45	0.55	0.54	0.43	2.7	2.9	2.2	2.6	28°	24°	27°	45°	22	25	29	30
6	1.57	2.16	1.73	1.47	0.63	0.71	0.76	0.55	2.5	3.0	2.3	2.7	24°	—	—	—	21	24	32	22
7	—		2.12	2.69	0.86		0.94	0.70	—		2.3	3.8	—		—	—	32	30	36	
	Diameter of inside of proloculum in mm.																			
	0.08	0.10	0.10	0.10													0.05	0.09	0.09	0.06

Specimen 2 is illustrated in figure 17; specimen 6 is illustrated in figure 18; all specimens from the Putnam Hill limestone.

The small shell of this species is fusiform in shape. Mature specimens have 7 or 8 whorls with half lengths for the 7th whorl ranging from 1.6 to 2.7 mm. and form ratios of 1: 2.1 to 1: 3.7. The axes of many specimens are broadly curved. Lateral slopes are straight or rarely concave. The ends are blunt.

The proloculum is small with an average inside diameter of 0.09 mm. Shells showing dimorphism are rare.

The protheca consists of tectum and diaphanotheca. This structure is evident in the walls of outer whorls where the lighter diaphanotheca shows up well, especially near the tunnel area. The epitheca is thin on the outer side of the wall and a little thicker on the inner side. The walls of the inner four whorls, which are more primitive than the outer whorls, have secondary deposits extending from the chomata to the poles. From the fifth whorl outward the chomata are symmetrical and higher than they are wide. They are about three fourths as high as the chamber.

The septa are highly fluted near the poles but only broadly fluted across the equator. The average septal count for 6 specimens was 10, 16, 18, 20, 25, 29, and 35 for 7 whorls.

The tunnel is well defined but crooked in most shells. Tunnel angles are mostly between 20° and 40° but the range is from 11° to 52°.

Remarks.—*Fusulina leei* is one of the more primitive species of this genus. The inner whorls are fusulinelloid with the thick deposits of epitheca on either side of the chomata. The fluting of the septa is not nearly as deep as it is in later species of *Fusulina*. Ohio specimens from the Putnam Hill limestone were originally classed as *Fusulinella serotina* by Thompson (1936). In 1944 the Pennsylvanian Committee of the National Research Council Committee on Stratigraphy (Moore *et al.*, 1944) listed *Fusulina serotina* and *Fusulina leei* from the Putnam Hill limestone of Ohio. The author believes that the specimens from Putnam Hill in Muskingum County, where the cotypes for *F. serotina* were collected, are indistinguishable from specimens found in the Putnam Hill limestone in northeastern Ohio and that they all fit the published descriptions of *Fusulina leei*.

Fusulina leei can be distinguished from *F. iowensis* var. *stouti* of the Pottsville formation by its slightly larger size, greater form ratio, and narrower chomata in outer whorls. It is more difficult to distinguish from *Fusulina carmani* of the Vanport limestone. The distinguishing features are mentioned under the description of that species.

Distribution.—This species occurs in the Putnam Hill limestone of central and northeastern Ohio; the Curlew limestone in Saline and Gallatin counties, Illinois (Dunbar and Henbest, 1942); the Cherokee shale of Lucas and Monroe counties, Iowa (Thompson, 1934), and Mayes (Skinner, 1931) and Pontotoc (Thompson, 1935) counties, Oklahoma; the Madera limestone of Sandoval County, New Mexico (Henbest and Read, 1944); the Hartville formation, Platte County, Wyoming (Love, Henbest, and Denson, 1953); and possibly in the Tensleep sandstone of Fremont County, Wyoming (Henbest, 1954).

Fusulina carmani (Thompson) 1936

Figures 13, 14, and 20

Fusulina cylindrica de Verneuil. 1846. Amer. Jour. Sci. 2nd S. 2: 293. Buhrstone, Ohio.

Fusulina cylindrica Herrick. 1887. Denison Univ. Sci. Lab. Bull. 2: 50, pl. 3, fig. 20. Vanport flint, Licking County, Ohio.

Fusulina secalica Mark. 1911. Denison Univ. Sci. Lab. Bull. 16: 278, 286. Vanport flint, Licking County, Ohio.

Fusulina sp., Stout. 1918. Ohio Geol. Survey Bull. 21: 149, 155, 157. Vanport horizon, Muskingum County, Ohio.

Fusulinella carmani Thompson. 1936. Jour. Paleont. 10: 678–679, pl. 91, figs. 10–12. Vanport horizon, Muskingum County, Ohio.

The shell of this species is small and fusiform in shape. Lateral slopes are straight in most specimens and the ends are bluntly pointed. The axis is straight or slightly curving. The first whorl is subspherical, but subsequent whorls are elongate. Mature specimens have 7 or 8 whorls. The half length is about 1.9 mm. in the 6th whorl and 2.2 mm. in the 7th whorl, and the form ratios average 1: 2.6 and 1: 2.0 in those two whorls respectively.

The proloculum is round with an average inside diameter of 0.09 mm., but some specimens measure up to 0.12 mm. Dimorphism has not been noted in any of the material collected.

The shell walls are thin. The protheca consists of a tectum and diaphanotheca. The diaphanotheca can be seen in the outer whorls of most thin sections on either side of the tunnel area. The epitheca deposits are thin. The chomata are small; on the first two whorls they are flat and extend towards the poles, but on the outer whorls they are symmetrical and as high as they are wide.

The septa are fluted along their length, especially in the polar regions. The septal count for 6 sagittal sections averages 11, 16, 18, 21, 23, 25, and 30 for seven whorls.

The tunnel is narrow and in most shells it is straight. The tunnel angles in the specimen pictured in figure 13 are 23°, 27°, 29°, 30°, and 32°, for five whorls. This is average for this species in Ohio but some specimens have tunnel angles up to 44° in the fifth whorl.

Remarks.—This species was originally placed in the genus *Fusulinella* with the observation that it was a transitional form between *Fusulinella* and *Fusulina* (Thompson, 1936, p. 679). In Correlation of Pennsylvanian Formations of North America (Moore *et al.*, 1944) it is called *Fusulina carmani* on page 684; and this name is also used in later publications (Henbest and Read, 1944; Thompson and Thomas, 1953). In the specimens examined, the fluting of the septa

extends across the middle of the shell and the chomata are narrow. Because these are characteristics of the genus *Fusulina* the author believes that these Ohio specimens belong to that genus.

F. carmani resembles *F. leei*, which is found in the Putnam Hill limestone of Ohio but it is slightly longer with greater form ratio and greater tunnel angle, while the proloculum is somewhat smaller and the septa are more highly fluted.

Distribution.—In Ohio *F. carmani* has been found in the Vanport limestone and flint in Licking, Muskingum, Tuscarawas, and Wayne counties. Henbest and Read (1944) compared specimens which they found in the Madera limestone, Sandoval County, New Mexico, to this species.

TABLE 4

Measurements for Fusulina carmani (*Thompson*)

Whorl	Half length in mm.				Radius vector in mm.				Form ratio				Tunnel angle				Septal count			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	5	6	7	8
1	0.16	0.20	0.14	0.16	0.08	0.08	0.10	0.08	2.0	2.5	1.4	2.0	27°	23°	20°	31°	—	10	9	12
2	0.39	0.40	0.27	0.31	0.14	0.14	0.15	0.14	2.9	2.8	1.8	2.2	29°	27°	33°	28°	15	13	13	17
3	0.67	0.69	0.47	0.55	0.20	0.22	0.22	0.22	3.3	3.1	2.1	2.5	—	29°	29°	25°	17	19	16	18
4	0.92	1.31	0.92	0.73	0.30	0.35	0.36	0.35	3.1	3.8	2.6	2.1	—	30°	35°	34°	25	23	19	20
5	1.33	1.67	1.16	1.16	0.45	0.53	0.49	0.47	3.0	3.2	2.4	2.4	—	32°	31°	33°	23	26	20	24
6	1.76	2.41	1.49	1.70	0.62	0.71	0.65	0.65	2.8	3.4	2.3	2.6	—	—	35°	25°	25	—	24	24
7	2.24		—	2.39	0.82		0.86	0.82	2.7		—	2.9	—		—	—				30
	Diameter of inside of proloculum in mm.																			
	0.06	0.09	0.07	0.08													0.07	0.09	0.06	—

Specimen 2 is illustrated in figure 13; specimen 5 is illustrated in figure 14; all specimens from the Vanport limestone.

Fusulina sp.

Figure 12

Fusulina sp. Stout. 1917. Ohio Geol. Survey Bull. 21: 175. Hamden limestone, Muskingum County, Ohio.

The one fusulinid specimen which the author found in the Hamden limestone is not considered enough basis for specific designation. An axial section of the specimen shows the deeply fluted septa of the genus *Fusulina*. The shell is thickly fusiform with bluntly pointed ends. From the 6th whorl outward the ends are elongated. There are 8 whorls with a total half-length of 1.63 mm. and a form ratio of 1: 2.3.

This specimen is microspheric. There is a small proloculum and a juvenarium consisting of one whorl (not clearly seen in the photograph).

The spirotheca is thin in all whorls but slightly thicker in the outer whorls. The tectorium is thicker on the inside of the spiral than on the outside. In whorls seven and eight the diaphonotheca is the widest part of the wall over the tunnel.

On the inner whorls the chomata are asymmetrical, tapering to the poles. From the fourth whorl outward the chomata are narrow and small.

Septa are slightly fluted on the inner whorls and highly fluted on the outer whorls throughout their length.

The tunnel is narrow and crooked. The tunnel angle increases from 11° in the second whorl to 31° in the seventh whorl.

Remarks.—The septa are more highly fluted in this specimen than in *Fusulina carmani* of the Vanport limestone. While this specimen resembles several described species from rocks of similar age in the mid-continent region, the measurements do not fall within the range of the published measurements of any one of them. Its classification must await the finding of more specimens.

Distribution.—This specimen was found in nodular Hamden limestone at locality 75 in Cass Township, Muskingum County. No fusulinids have been found in other exposures of this member.

TABLE 5

Measurements for Fusulina *sp.*

Whorl	Half length in mm.	Radius vector in mm.	Form ratio	Tunnel angle	Diameter of inside of proloculum in mm.
1	0.06	0.05	1.2	—	0.03
2	0.12	0.08	1.5	11°	
3	0.20	0.13	1.5	13°	
4	0.32	0.18	1.8	19°	
5	0.45	0.25	1.8	16°	
6	0.67	0.35	1.9	29°	
7	1.06	0.49	2.2	31°	
8	1.63	0.71	2.3		

Specimen from the Hamden limestone, illustrated in figure 12.

TABLE 6

Measurements for Wedekindellina euthysepta (*Henbest*)

Whorl	Half length in mm.				Radius vector in mm.				Form ratio				Tunnel angle					Septal count		
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	5	6	7	8
1	0.10	0.10	0.08	0.08	0.05	0.07	0.05	0.06	2.0	1.4	1.6	1.3	—	—	—	—	—	11	—	10
2	0.22	0.22	0.14	0.20	0.08	0.09	0.06	0.08	2.8	2.4	2.3	2.5	—	19°	—	—	—	16	13	13
3	0.38	0.32	0.26	0.30	0.11	0.11	0.09	0.10	3.4	2.9	2.9	3.0	19°	27°	—	—	14	17	17	15
4	0.51	0.48	0.53	0.41	0.14	0.16	0.12	0.14	3.6	3.0	4.4	2.9	17°	23°	28°	—	15	17	19	18
5	0.77	0.64	0.75	0.57	0.19	0.21	0.15	0.19	4.0	3.1	4.9	3.0	25°	25°	27°	23°	17	—	22	23
6	1.06	0.86	0.90	0.71	0.24	0.27	0.20	0.25	4.4	3.2	4.5	2.9	23°	30°	27°	14°	20	—	—	20
7	1.25	1.15	—	0.82	0.32	0.34	0.25	0.33	3.9	3.4	—	2.5	22°	28°	—	—	20	—		22
8	—	1.60	—	1.02	0.42	0.42	0.32	0.39	—	3.8	—	2.6	—	—	—			—		—
9		—			0.54					—				—				—		
	Diameter of inside of proloculum in mm.																			
	0.05	—	0.04	—													—	0.05	—	0.05

Specimen 2 is illustrated in figure 15; all specimens are from the Vanport limestone.

Wedekindellina euthysepta (Henbest) 1928

Figures 15, 16, and 20

Fusulinella euthusepta Henbest. 1928. Jour. Paleont. 2: 80–81, pl. 8, figs. 6–8; pl. 9, figs. 1, 2, 5. Stonefort limestone, Saline and Williamson counties, Illinois.

Wedekindella euthysepta Dunbar and Henbest. 1930. Amer. Jour. Sci. 5th S. 20: 357–364.

Wedekindia euthysepta Dunbar and Henbest. 1931. Amer. Jour. Sci. 5th S. 21: 458. (The generic name *Wedekindella* was preoccupied).

Fusulina euthusepta White. 1932. Univ. Texas Bull. 3211: 24–25, pl. 1, figs. 1–3. Dennis limestone, Parker County, Texas.

Wedekindellina euthysepta Dunbar and Henbest. 1933. Cushman Lab. Foram. Research Special Publ. 4: p. 134, key plate 10, figs. 13–15. (The generic name *Wedekindia* was preoccupied).

Wedekindellina euthysepta Thompson. 1934. Univ. Iowa Stud. Nat. Hist. 16: 282–285, pl. 20, figs. 1, 2, 7, 9, 12, 13, 17, 22, 24–27. Cherokee shale, Lucas, Monroe, and Van Buren counties, Iowa.

Wedekindellina dunbari Thompson. 1934. Univ. Iowa Stud. Nat. Hist. 16: 285–287, pl. 20, figs. 3, 6, 15, 16, 20, 21. Cherokee shale, Lucas and Monroe counties, Iowa.

Wedekindellina euthysepta Needham. 1937. New Mexico School of Mines 14: 27–29, pl. 3, figs. 6–8. Lower part of Magdalena formation in central New Mexico.

Wedekindellina euthysepta Dunbar and Henbest. 1942. Illinois Geol. Survey Bull. 67: 98–100, pl. 8, figs. 1–23; pl. 9, figs. 1–4. Stonefort limestone, Saline and Williamson counties; Stonefort (?) limestone, Jackson County; marine zone above Colchester No. 2 coal, Madison, Greene and Adams counties; and Seahorne limestone, Mercer County, all in Illinois.

Wedekindellina euthusepta Alexander. 1954. Oklahoma Geol. Survey Circular 31: 20–21, pl. 1, fig. 9. Fleming cap rock, southern Kansas.

Wedekindellina euthysepta has a small, tightly-coiled, elongate, pointed shell. Lateral slopes are straight with a slight tendency to be convex. The axis of coiling is straight, or nearly so, in all of the specimens sectioned. The proloculum is round, but all the whorls are elongate along the axis. The form ratio increases from about 1: 2.3 in the second whorl to about 1: 4.0 in the eighth whorl. Mature specimens have 8 whorls and an average half length of 1.5 mm.

The proloculum is very small with an average inside diameter of 0.05 mm. Dimorphism was not observed in any of the specimens sectioned.

The protheca is thin, but there are massive secondary deposits on the wall in all whorls except the outermost one, especially along the axis. The axial region is completely filled in on most specimens. The chomata are low and flat, and extend outward towards the poles.

The septa are straight and numerous. No fluting is evident in any of the sections prepared. The septal count on one characteristic section was 10, 13, 15, 18, 23, 20, and 22 for seven whorls.

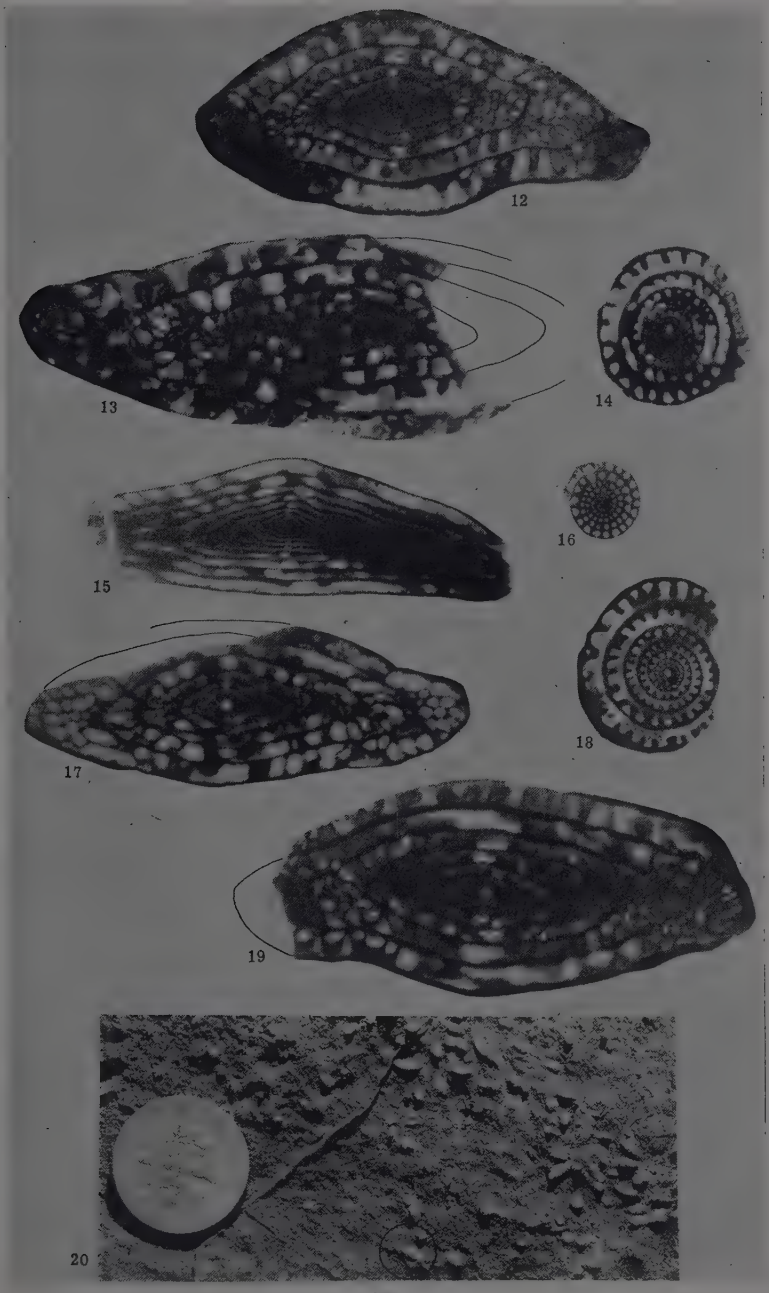
The tunnel is narrow; it is straight on most specimens but erratic on a few. The tunnel angle ranges from 17° to 30° with only a few degrees difference in angle on any one specimen from inner whorls outward.

Remarks.—Even in the field, *Wedekindellina euthysepta* is not likely to be confused with any other species of fusulinid found in Ohio, for its characteristic thin, pointed shape is discernible with the naked eye. It has been found associated with *Fusulina carmani* in the Vanport limestone and flint in all the outcrops of that horizon examined in which fusulinids were numerous.

EXPLANATION OF FIGURES IN PLATE II

All figures magnified ×20 except figure 20.

12. *Fusulina* sp., axial section from Hamden limestone, Muskingum County, locality 75. O. S. U. No. 22246.
13. *Fusulina carmani* (Thompson), axial section from Vanport limestone, Muskingum County, locality 17. O. S. U. No. 22247.
14. *Fusulina carmani* (Thompson), sagittal section from same locality. O. S. U. No. 22248.
15. *Wedekindellina euthysepta* (Henbest), axial section from Vanport limestone, Tuscarawas County, locality 9. O. S. U. No. 22249.
16. *Wedekindellina euthysepta* (Henbest), section perpendicular to the axis from the same locality. O. S. U. No. 22250.
17. *Fusulina leei* Skinner, axial section from Putnam Hill limestone, Stark County, locality 62. O. S. U. No. 22251.
18. *Fusulina leei* Skinner, sagittal section from Putnam Hill limestone, Coshocton County, locality 1. O. S. U. No. 22252.
19. *Fusulina leei* Skinner, axial section from Putnam Hill limestone, Coshocton County, locality 54. O. S. U. No. 22253.
20. *Fusulina carmani* and *Wedekindellina euthysepta* (circled) on the weathered surface of a piece of Vanport limestone from Tuscarawas County, locality 9 (slightly enlarged).


12
13
14
15
16
17
18
19
20

Distribution.—In Ohio *Wedekindellina euthysepta* has been found in the Vanport limestone at locality 24 in Licking County, localities 2, 17, and 40 in Muskingum County, locality 58 in Tuscarawas County, and locality 110 in Wayne County. It has been reported in the Stonefort limestone in southern Illinois (Henbest, 1928; Dunbar and Henbest, 1942); in the Cherokee shale in southern Iowa (Thompson, 1934); in the Fleming cap rock, southern Kansas (Alexander, 1954); in the Dennis limestone, Parker County, Texas (White, 1932); in the lower part of the Magadalena formation in central New Mexico (Needham, 1937), and in the Tensleep sandstone of Fremont County, Wyoming (Henbest, 1954).

Triticites ohioensis Thompson 1936

Figures 25, 26, 27, and 28

Fusulina secalica Condit. 1912. Ohio Geol. Survey Bull. 17. Cambridge limestone, southeastern Ohio.

Triticites ohioensis Thompson. 1936. Jour. Paleont. 10: 680, pl. 91, figs. 1–3. Brush Creek and Cambridge limestones, Gallia County, Ohio.

Triticites ohioensis Dunbar and Henbest. 1942. Illinois Geol. Survey Bull. 67: 130–132, pl. 19, figs. 1–22; pl. 20, figs. 20–24.

Triticites ohioensis, which is somewhat cigar-shaped, has the longest shell of all the fusulinid species found in Ohio; the mature specimens collected average 8 to 9 mm. in length. The first

TABLE 7

Measurements for Triticites ohioensis *Thompson*

Whorl	Half length in mm.				Radius vector in mm.				Form ratio				Tunnel angle					Septal count		
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	5	6	7	8
1	0.14	0.12	0.14	0.16	0.08	0.07	0.08	0.10	1.8	1.6	1.8	1.6	20°	18°	17°	29°	10	10	9	13
2	0.24	0.19	0.28	0.35	0.14	0.09	0.14	0.14	1.6	2.0	2.0	2.5	21°	21°	21°	29°	14	—	14	15
3	0.45	0.38	0.71	0.51	0.22	0.17	0.22	0.22	2.0	2.2	3.2	2.3	27°	29°	23°	34°	17	20	20	18
4	0.73	0.62	1.12	0.96	0.33	0.26	0.37	0.34	2.2	2.4	3.0	2.8	27°	30°	27°	38°	20	22	21	20
5	1.47	1.09	1.94	1.31	0.47	0.40	0.53	0.44	3.1	2.7	3.7	3.0	45°	25°	39°	60°	23	22	28	22
6	3.16	1.76	2.80	2.78	0.69	0.62	0.76	0.64	4.6	2.8	3.7	4.3	62°	—	52°	72°	23	29	31	26
7	4.28	2.90	3.67	4.00	0.92	0.84	1.02	—	4.7	3.5	3.6	—	—	—	—	—	27	31	34	26
8		4.13				1.05				3.9				—						
	Diameter of inside of proloculum in mm.																			
	0.06	0.06	0.08	0.09													0.08	—	0.06	—

Specimen 1 is illustrated in figure 25; specimen 5 is illustrated in figure 27; specimens 2, 3, and 7 are from the Brush Creek limestone, the rest are from the Cambridge limestone.

three or four whorls are fusiform in shape, but outer whorls are more elongate. Form ratio increases from 1: 2.7 in the third whorl to 1: 3.6 in the seventh.

The proloculum is small compared with the rest of the shell. Inside diameters average about 0.06 mm., except in specimens from localities 29 and 33 in Meigs and Perry counties respectively. The proloculi of these specimens average 0.1 mm. for inside diameter. No dimorphism was seen in the specimens sectioned.

The spiral wall is thin on the inner volutions. From the fourth whorl outward the typical schwagerinid details are evident: the thin tectum and the keriotheca with coarse alveoli. Chomata are asymmetrical on the inner volutions with epithecal deposits extending poleward. On outer whorls the chomata are small and narrow.

The septa are numerous in this species. The average septal count for the first seven whorls of 14 specimens was 11, 16, 19, 21, 23, 26, and 27. The septa are fluted in the polar regions of the shell, especially near the axis. They are essentially plane near the tunnel.

The tunnel angle, which is narrow in the inner volutions, widens considerably in the outer whorls. The tunnel angles for a typical specimen are: 20°, 21°, 27°, 27°, 45°, and 62°. The change in the size of the angle in this specimen comes in the fifth whorl, the same whorl in

which the chomata are small and narrow in contrast to the wide chomata of the first four whorls (fig. 25).

Remarks.—*T. ohioensis* may be distinguished from *T. cullomensis* and *T. skinneri* of the Ames limestone of Ohio by its greater length and greater form ratio in mature specimens. The specimens from Meigs and Perry counties with larger proloculi may prove to be a different species or a variety, but there is not enough evidence in the thin sections made to establish this. The published measurements of Illinois specimens of *T. ohioensis* (Dunbar and Henbest, 1942) average greater than measurements made by the author of Ohio specimens, but they fall within similar limits. Specimens from locality 7 were collected in the same township as the cotypes for this species.

Distribution.—*T. ohioensis* has been found in the Cambridge limestone in Lawrence, Gallia, Meigs, Perry, and Muskingum counties, and in the Brush Creek limestone in Gallia County, Ohio. Specimens found in the Portersville limestone in Athens County, Ohio compare in measurements and appearance to this species. In Illinois it is described from the Livingston limestone of Edgar and Christian counties, the Omega limestone of Effingham County (Dunbar and Henbest, 1942), and the Millersville limestone of Coles County (Wanless, 1955). It has also been reported in the Graford formation of West Texas (Myers, Stafford, and Burnside, 1956), and forms compared to *T. ohioensis* are listed from Division II of the Hartville formation, Platte County, Wyoming (Love, Henbest, and Denson, 1953).

TABLE 8

Measurements for Triticites cullomensis *Dunbar and Condra*

Whorl	Half length in mm.				Radius vector in mm.				Form ratio				Tunnel angle				Septal count	
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	5	6
1	0.18	0.16	0.14	0.16	0.10	0.06	0.04	0.08	1.8	2.7	3.5	2.0	23°	28°	—	—	—	9
2	0.37	0.28	0.28	0.35	0.16	0.09	0.09	0.14	2.3	3.1	3.1	2.5	31°	31°	—	31°	15	13
3	0.59	0.42	0.44	0.64	0.24	0.14	0.19	0.22	2.5	3.0	2.3	2.9	41°	43°	51°	40°	16	15
4	0.82	0.82	0.81	0.86	0.32	0.21	0.29	0.35	2.6	3.9	2.8	2.5	42°	39°	51°	64°	18	17
5	1.33	1.22	1.14	1.18	0.47	0.30	0.43	0.48	2.8	4.0	2.7	2.5	—	—	53°	45°	20	16
6		1.63	1.74	1.44		0.45	0.63	0.67		3.6	2.7	2.1		—	—	43°	22	19
7		2.04	2.15	2.02		0.55	0.81	0.83		3.7	2.6	2.4		—	—	—	23	23
	Diameter of inside of proloculum in mm.																	
	0.08	0.04	0.06	—													0.06	—

Specimen 1 is illustrated in figure 23; specimen 5 is illustrated in figure 24; all specimens from the Ames limestone.

Triticites cullomensis Dunbar and Condra 1927

Figures 23 and 24

Fusulina secalica Condit. 1912. Ohio Geol. Survey Bull. 17: 84, 289. Ames limestone, Gallia County, Ohio.

Triticites cullomensis Dunbar and Condra. 1927. Nebraska Geol. Survey 2nd S. 2: 93–95, pl. 5, figs. 5–10. Shawnee group, eastern Kansas and Nebraska.

Triticites cullomensis emend. Dunbar and Henbest. 1942. Illinois Geol. Survey Bull. 67: 135, 136, pl. 23, figs. 13–18.

Triticites cullomensis is medium in size for the genus. The shell is fusiform in shape with gently sloping sides and bluntly pointed ends. The axis of coiling is straight. Mature specimens have seven or eight whorls, a total length of about 4.3 mm., and a form ratio between 1: 3.0 and 1: 3.8.

The proloculum is small. Inside diameters range from 50 to 80 microns.

The spirotheca consists of a thin outer tectum and a keriotheca. On outer whorls the keriotheca is thick, with coarse alveoli; on inner whorls it is thin with little evident structure. The septa are fluted in the polar regions and plane across the center of the shell. The septal count for an average sagittal section is 9, 15, 15, 17, 18, 19, 23.

The tunnel is straight in most specimens with a regular increase of tunnel angle outward. The tunnel angles for the first five whorls of a typical specimen are 23°, 31°, 41°, 45°, and 55°.

The chomata are small. In the inner whorls they are flat and wide and on the outer whorls they are higher and asymmetrical on some specimens.

Remarks.—Although *T. cullomensis* resembles very closely *T. skinneri*, which occurs in the Ames limestone of central Ohio, it has a larger proloculum and somewhat larger tunnel angle. The length and form ratio of the shell is smaller for *T. cullomensis* than it is for *T. ohioensis* of the Cambridge limestone of Ohio.

Distribution.—*T. cullomensis* is found in the Ames limestone of Gallia County in southern Ohio and at Pittsburgh, Pennsylvania (Dunbar and Henbest, 1942). The holotype is from the Cullom limestone (Westerville limestone) of Nebraska. It has also been found in the Graham group in Jack County, Texas (White, 1932), in the Wendover group of Wyoming (Condra, Reed, and Scherer, 1940), and the Oquirrh formation of Utah (Thompson, Verville, and Bissell, 1950).

Triticites skinneri Thompson 1936

Figures 21 and 22

Fusulina secalica Condit. 1912. Ohio Geol. Survey Bull. 17: 127, 138, 287. Ames limestone, Perry and Morgan counties, Ohio.

Triticites skinneri Thompson. 1936. Jour. Paleont. 10: 682, pl. 91, figs. 4–7. Ames limestone, Perry County, Ohio.

TABLE 9

Measurements for Triticites skinneri *Thompson*

Whorl	Half length in mm.				Radius vector in mm.				Form ratio				Tunnel angle				Septal count			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	5	6	7	8
1	0.06	0.10	0.16	0.10	0.06	0.06	0.08	0.06	1.0	1.7	2.0	1.7	19°	—	—	—	10	—	—	—
2	0.16	0.22	0.32	0.22	0.08	0.09	0.13	0.10	2.0	2.4	2.5	2.2	—	—	15°	25°	15	—	17	—
3	0.31	0.39	0.54	0.35	0.12	0.12	0.24	0.16	2.5	3.2	2.3	2.1	35°	—	24°	38°	20	—	21	17
4	0.53	0.65	0.86	0.61	0.18	0.18	0.32	0.27	2.9	3.6	2.7	2.3	36°	—	21°	32°	20	17	23	18
5	0.92	0.94	1.22	1.08	0.29	0.27	0.48	0.39	3.2	3.5	2.5	2.8	44°	—	—	36°	24	22	28	21
6	1.43	1.16	1.47	1.69	0.43	0.39	0.67	0.55	3.4	3.0	2.2	3.1	45°	—	—	53°	25	25	27	21
7	1.94	1.39	1.72	2.55	0.61	0.57	0.93	0.73	3.2	2.4	1.9	3.5	42°	—	—	—	32	31	—	—
8	2.24	2 00			0 86	0.80			2.6	2.5			—	—						
	Diameter of proloculum in mm.																			
	0.03	0 04	0.03	0.04													0 06	0 04	—	—

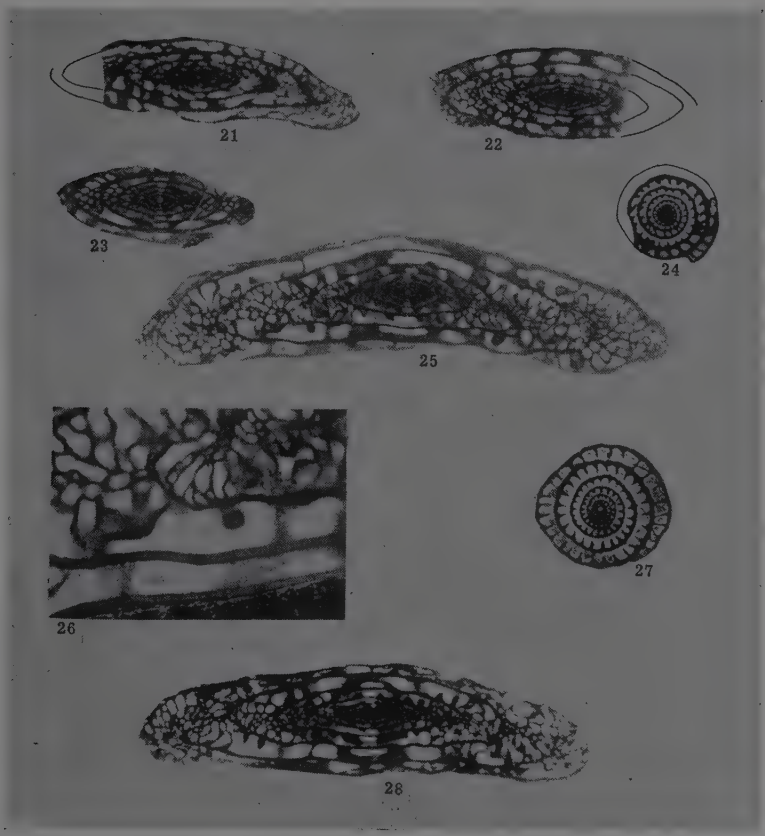
Specimen 1 is illustrated in figure 22; specimen 4 is illustrated in figure 21; specimen 4 is from the Gaysport limestone, all others are from the Ames limestone.

The shell of *Triticites skinneri* is small with a slightly inflated fusiform shape. The first whorl is subspherical in some specimens, but all other whorls are fusiform. The axis of coiling is straight. Mature specimens have seven or eight whorls. Measurements for the seventh whorl of a typical specimen are: half length, 1.9 mm.; radius vector, 0.79 mm.; and form ratio, 1: 2.4. The largest specimen measured had 8 whorls and a total length of 5.2 mm. with a form ratio of 1: 3.0.

The distinguishing feature of this species is the very small proloculum. The largest proloculum measured had an inside diameter of 61 microns, but the average is between 40 and 50 microns.

The spirotheca is thin in the inner volutions and somewhat thicker on outer whorls. Wall thickness for one specimen from Perry County was 10, 10, 15, 20, 31, 51, 61, and 73 microns in the first eight volutions. The wall is composed of tectum and keriotheca. Rather coarse alveoli are evident in the keriotheca from the fourth whorl outward.

The septa are highly fluted near the poles and straight or gently folded across the center. The septal count for a typical specimen is 10, 15, 20, 20, 24, 25, and 32 for seven whorls.



EXPLANATION OF FIGURES IN PLATE III

All figures magnified ×10 except figure 26.

21. *Triticites skinneri* Thompson, axial section from Gaysport limestone, Athens County, locality 18. O. S. U. No. 22254.
22. *Triticites skinneri* Thompson, axial section from Ames limestone, Perry County, locality 33. O. S. U. No. 22255.
23. *Triticites cullomensis* Dunbar and Condra, axial section from Ames limestone, Gallia County, locality 6. O. S. U. No. 22256.
24. *Triticites cullomensis* Dunbar and Condra, sagittal section from same locality. O. S. U. No. 22257.
25. *Triticites ohioensis* Thompson, axial section from Cambridge limestone, Gallia County, locality 7. O. S. U. No. 22258.
26. Detail of wall from same thin section showing alveoli in outer whorls (×30).
27. *Triticites ohioensis* Thompson, sagittal section from Cambridge limestone, Gallia County, locality 7. O. S. U. No. 22259.
28. *Triticites ohioensis* Thompson, axial section from Brush Creek limestone, Gallia County, locality 14. O. S. U. No. 22260.

The tunnel angle varies from 15 to 53 degrees in the specimens measured. In most specimens it is about 30° with not much increase from the inner whorls outward. The tunnel is not well defined in axial sections because the chomata are small and inconspicuous. On inner whorls they are low and wide. On outer whorls the height of the chomata is about as great as the width of it, but only half as high as the chamber.

Remarks.—*T. skinneri* is very similar to *T. cullomensis* which also occurs in the Ames limestone. The two species cannot be distinguished in the field. In thin sections they may be differentiated by the smaller proloculum and somewhat smaller tunnel angle of *T. skinneri*. It is distinguished from *T. ohioensis* of the Cambridge limestone of Ohio by its smaller size and more obese shell. The difference is great enough to be seen in the field without the use of thin sections.

Distribution.—*T. skinneri* has been found in central and eastern Ohio in the Ames limestone in Athens, Perry, Morgan, Muskingum, and Columbiana counties, and in the Gaysport limestone of Athens County. Thompson's cotypes came from Bearfield Township, Perry County, Ohio (loc. 33).

COLLECTING LOCALITIES

A representative list of collecting localities is given here. Collections were made by the author unless otherwise indicated.

Loc. 1.—Lower Mercer and Putnam Hill limestones, Coshocton County, Washington Township (Frazeysburg quadrangle), southwestern part of the township, one-half mile south of Graham Corners. Lower Mercer limestone in bed of Opossum Run at waterfall and Putnam Hill limestone near the top of ridges east and west of Opossum Run. *Fusulinella iowensis* and *F. iowensis* var. *stouti* in Lower Mercer limestone and *Fusulina leei* in Putnam Hill limestone.

Loc. 2.—Vanport limestone, Muskingum County, southwest Muskingum Township (Frazeysburg quadrangle), outcrop along township road at 977 feet elevation, three-fourths mile north of Ohio Route 156 and three-fourths mile east of Big Run. *Fusulina carmani* and *Wedekindellina euthysepta*.

Loc. 4.—Lower Mercer limestone, Muskingum County, Hopewell Township (Zanesville quadrangle), ledge of limestone in small waterfall near the headwaters of a small stream which enters a branch of Poverty Run one and one-half miles north of Sterling. *Fusulinella iowensis* and *F. iowensis* var. *stouti*.

Loc. 5.—Ames limestone, Gallia County, Morgan Township (Bidwell quadrangle), SW ¼, sec. 28. Small outcrop of nodular limestone near top of hill near old road. *Triticites cullomensis* abundant.

Loc. 6.—Ames limestone, Gallia County, Morgan Township (Bidwell quadrangle), west edge SW ¼, sec. 19. Limestone on top of bank along road at about 700 feet elevation. *Triticites cullomensis* abundant.

Loc. 7.—Cambridge limestone and shale, Gallia County, Perry Township (Bidwell quadrangle), SW ¼, sec. 35. Fossils in shale under limestone in creek near road, one mile east of Patriot. *Triticites ohioensis* very abundant.

Loc. 8.—Cambridge limestone and shale, Gallia County, Harrison Township (Bidwell quadrangle), SE ¼, sec. 30. Fossils in shale over limestone along Fox Brook, 0.6 mile south of its mouth and just west of road. *Triticites ohioensis* very abundant.

Loc. 9.—Putnam Hill and Vanport limestones, Tuscarawas County, Sandy Township (Dover quadrangle). North of Ohio Route 8, one mile southwest of Mineral City; Putnam Hill limestone near the railroad level, and Vanport limestone 44 feet higher. *Fusulina leei* rare in Putnam Hill limestone; *Wedekindellina euthysepta* and *Fusulina carmani* very abundant in the Vanport limestone.

Loc. 12.—Ames limestone, Athens County, Trimble Township (New Lexington quadrangle), NW ¼, NE ¼ sec. 6. Collected by M. T. Sturgeon and R. E. Abbott. *Triticites skinneri*.

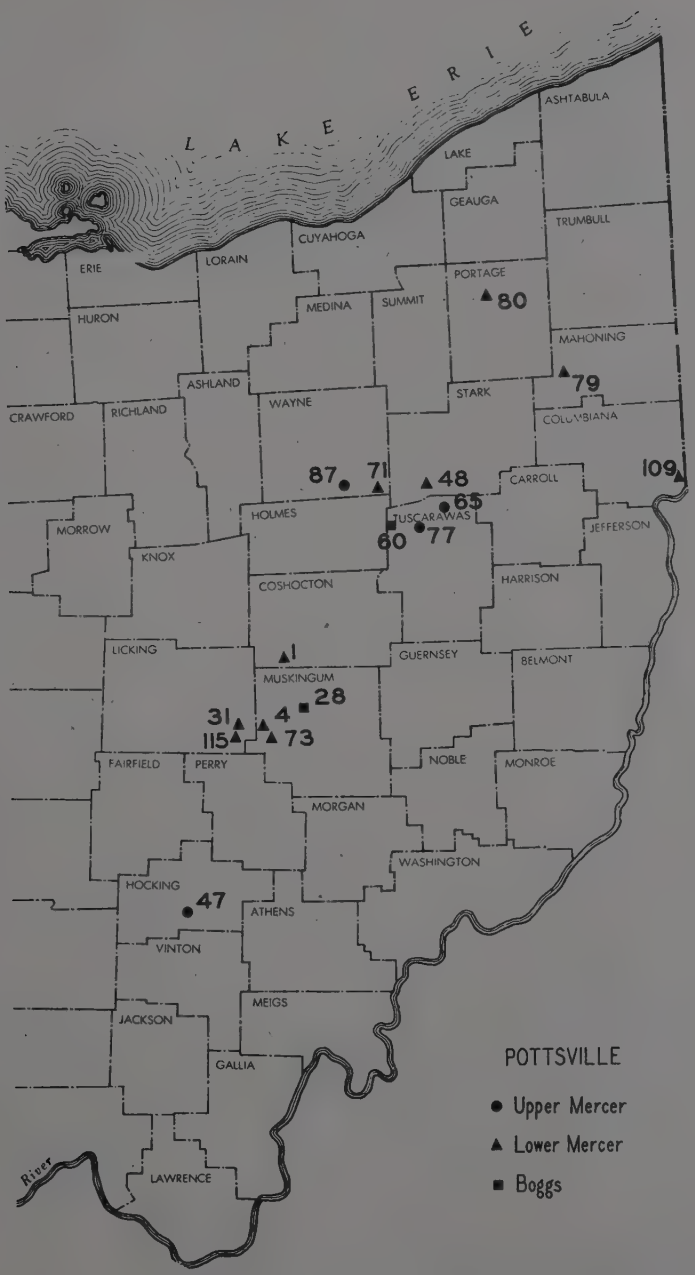


FIGURE 2. Collecting Localities in the Pottsville Series

Loc. 14.—Brush Creek horizon, Gallia County, Perry Township (Bidwell quadrangle), NE ¼, sec. 28. Sandy, fossiliferous material along road at top of hill west of Gage. Fusulinids preserved as silicified molds. Collected by Oliver Blake. *Triticites ohioensis.*

Loc. 15.—Brush Creek limestone, Gallia County, Raccoon Township (Bidwell quadrangle), east center sec. 35. Along the road. Collected by Oliver Blake. *Triticites ohioensis.*

Loc. 16.—Putnam Hill limestone, Muskingum County, Springfield Township (Zanesville quadrangle). Ledge of limestone in high bank across U. S. Route 40 from roadside park just west of western city limits of Zanesville. *Fusulina leei* rare.

Loc. 17.—Vanport flint and limestone, Muskingum County, Hopewell Township (Zanesville quadrangle), SE ¼, SE ¼, partial sec. 15 N. Outcrop along abandoned road. This is near the collecting locality for cotypes of *Fusulina carmani*. *Fusulina carmani* very abundant, *Wedekindellina euthysepta.*

Loc. 18.—Gaysport limestone, Athens County, Athens Township, (Athens quadrangle), SW ¼, NW ¼, sec. 17. Collected by M. T. Sturgeon. *Triticites skinneri.*

Loc. 20.—Ames limestone, Athens County, Dover Township (Athens quadrangle), SW ¼, SW ¼, sec. 1. Collected by M. T. Sturgeon. *Triticites skinneri.*

Loc. 22.—Ames limestone, Muskingum County, Blue Rock Township (Philo quadrangle), east central sec. 27. Limestone in north bank of Dry Riffle Run near Ohio Route 340. *Triticites skinneri* abundant.

Loc. 24.—Vanport flint, Licking County, Hopewell Township (Thornville quadrangle). Exposure of flint along Flint Ridge Road, near crossroads one-half mile from western edge of township. *Fusulina carmani* and *Wedekindellina euthysepta* abundant.

Loc. 28.—Boggs limestone, Muskingum County, Muskingum Township (Frazeysburg quadrangle). Limestone in bed of Blunt Run just east of sec. 20. *Fusulinella iowensis* rare.

Loc. 29.—Cambridge limestone and shale, Meigs County, Rutland Township (Pomeroy quadrangle), SE ¼, NW ¼, sec. 35. Collected by Herb Feldsted. *Triticites ohioensis* very abundant.

Loc. 30.—Putnam Hill limestone, Tuscarawas County, Fairfield Township (Dover quadrangle), NW ¼ ,SW ¼, sec. 6. Along Ohio Route 8 at Dover Dam, ledge of limestone about 6 feet above road level. *Fusulina leei* rare.

Loc. 31.—Lower Mercer limestone, Licking County, southwest part of Hopewell Township (Thornville quadrangle). Outcrop of shaly limestone at an elevation of 1130 feet, along north-south township road one half mile east of township boundary and one mile north of U. S. Route 40. *Fusulinella iowensis* and *F. iowensis* var. *stouti* both abundant.

Loc. 33. -Cambridge and Ames limestones, Perry County, Bearfield Township (New Lexington quadrangle), west central sec. 24. Ledge of Cambridge limestone in stream bed below Anderson coal, and blocks of Ames limestone in field near head of gully. *Triticites ohioensis* abundant in Cambridge limestone and *Triticites skinneri* in Ames. The collecting site for the cotypes of *Triticites skinneri* is nearby.

Loc. 38.—Cambridge limestone, Morgan County, York Township (McConnelsville quadrangle), SE ¼, SW ¼, sec. 35. Exposure in gully which is parallel to and west of hill road. The section is approximately:

	Feet	Inches
Coal	1	6
Interval	7	
Cambridge limestone with 8 inch fusulinid coquina at top	2	

Triticites ohioensis very abundant.

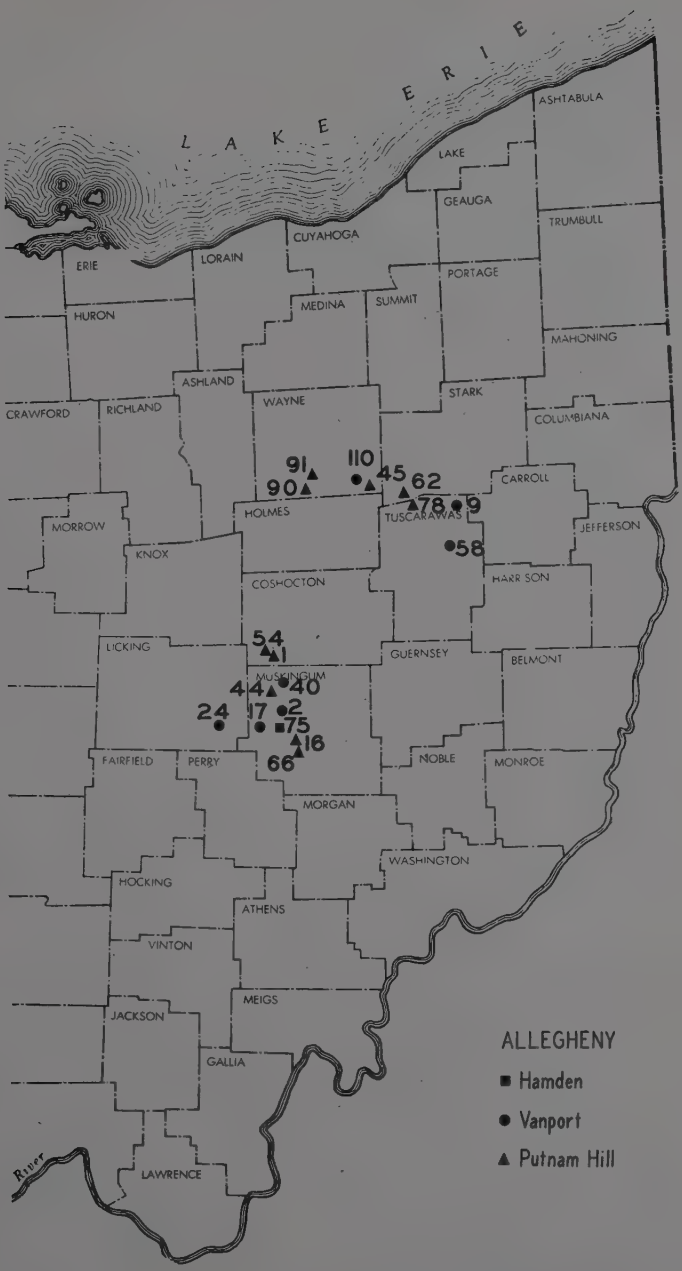


FIGURE 3. Collecting Localities in the Allegheny Series

Loc. 40. Vanport limestone, Muskingum County, Cass Township (Frazeysburg quadrangle). Limestone exposure at an elevation of 1007 feet at the Y in the road which runs along The Highlands south of partial sec. 14. *Fusulina carmani* and *Wedekindellina euthysepta* abundant.

Loc. 44.—Putnam Hill Limestone, Muskingum Country, Cass Township (Frazeysburg quadrangle). Ledge of limestone at an elevation of approximately 1000 feet, by the road along The Highlands one and one-half miles east of Frazeysburg. *Fusulina leei.*

Loc. 45.—Putnam Hill limestone, Wayne County, Paint Township (Navarre quadrangle), SW ¼, SE ¼, sec. 9. Outcrop of Putnam Hill limestone near the top of the hill on the north side of the road cut on U. S. Route 250, three-quarters of a mile northwest of Mount Eaton. *Fusulina leei* abundant.

Loc. 47.—Upper Mercer flint, Hocking County, Washington Township(Zaleski quadrangle), SW ¼, NE ¼, sec. 5. Samples collected in strip mine by John Hall. *Fusulinella iowensis.*

Loc. 48.—Lower Mercer limestone, Stark County, Bethlehem Township (Navarre quadrangle), SW ¼, SW ¼, sec. 16. Ledges of Lower Mercer limestone on either side of railroad cut where Wheeling and Lake Erie Railroad passes under the road. *Fusulinella iowensis* common.

Loc. 54.—Putnam Hill limestone, Coshocton County, Pike Township (Frazeysburg quadrangle), east central sec. 20. Ledge of dark blue-gray limestone along the road at an elevation of 1036 feet. *Fusulina leei* abundant.

Loc. 58.—Vanport limestone, Tuscarawas County, Goshen Township (Uhrichsville quadrangle). Along Ohio Route 39, one and one half miles east of New Philadelphia, opposite the road which comes in from the north along Pleasant Valley. Collected by Raymond Lamborn. *Fusulina carmani and Wedekindellina euthysepta.*

Loc. 60.—Boggs limestone, Tuscarawas County, Wayne Township (Navarre quadrangle), center partial sec. 3. Shaly limestone on the west side of the road. *Fusulinella iowensis* rare.

Loc. 62. Putnam Hill limestone, Stark County, Sugar Creek Township (Navarre quadrangle), SE ¼, NE ¼, NE ¼, sec. 36. Along private road. *Fusulina leei* abundant.

Loc. 65. Upper Mercer limestone, Tuscarawas County, Lawrence Township (Dover quadrangle). Ledge of Upper Mercer limestone in railroad cut at Zoar Station at an elevation of 950 feet. *Fusulinella iowensis* common.

Loc. 66. -Putnam Hill limestone, Muskingum County, city of Zanesville (Zanesville quadrangle). Type section for the Putnam Hill limestone, west side of the Muskingum River, south of the Y bridge. *Fusulina leei.*

Loc. 67.- Upper Mercer (?) limestone, Wayne County, Paint Township (Navarre quadrangle), NE ¼, SE ¼, sec. 13. Abandoned, water-filled quarry; elevation at base of limestone, 1105 feet. Collected by H. Gray Multer.

Loc. 71.- Lower Mercer limestone, Wayne County, Paint Township (Navarre quadrangle), west central sec. 23. Limestone exposed by a small stream at an elevation of 1117 feet. Collected by H. Gray Multer. *Fusulinella iowensis.*

Loc. 73. Lower Mercer limestone, Muskingum County, Hopewell Township (Zanesville quadrangle), center partial sec. 18. Limestone in roadside ditch about a mile north of Mt. Sterling. *Fusulinella iowensis* and *F. iowensis* var. *stouti* very abundant.

Loc. 75. - Hamden limestone, Muskingum County, Falls Township (Zanesville quadrangle). Nodules of limestone along either side of the road three miles east of Dillon and near the western edge of Falls township. *Fusulina* sp. rare.

Loc. 77. -Upper Mercer limestone, Tuscarawas County, Franklin Township (Navarre quadrangle), center S ½ partial sec. 8. Along road about three fourths mile north of Winfield near an elevation of 980 feet. Collected by Henry Gray. *Fusulinella iowensis* abundant.

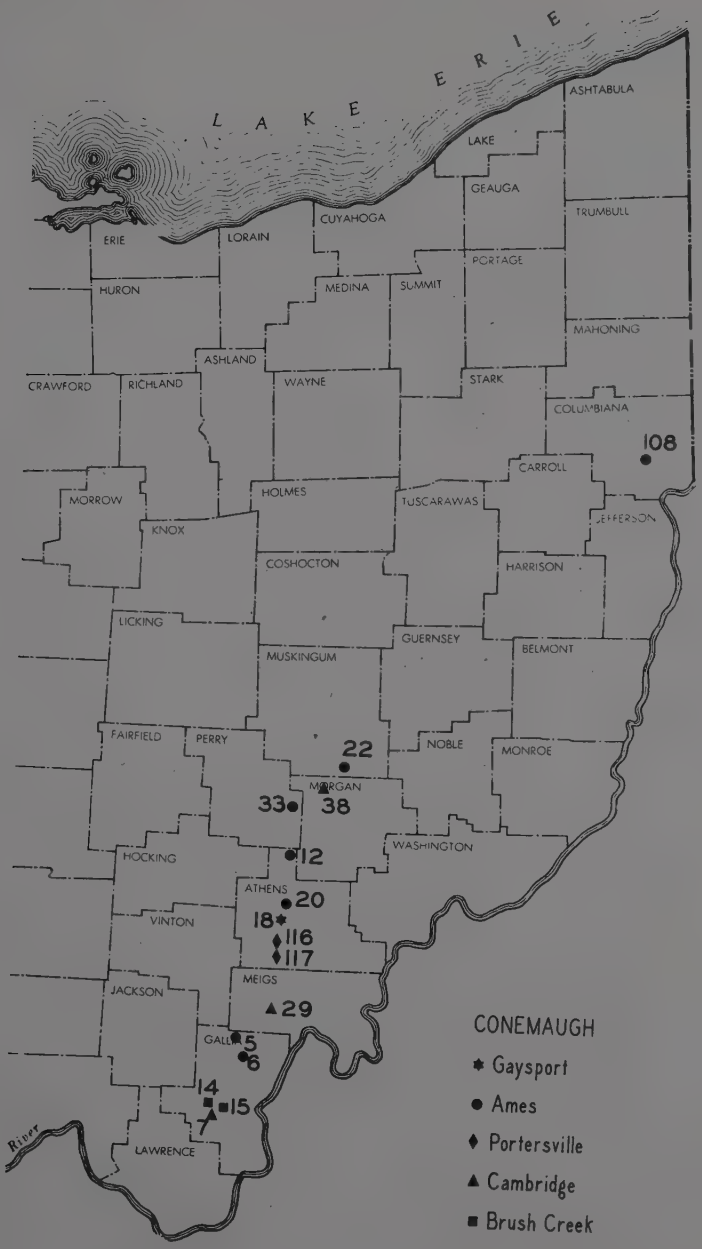


FIGURE 4. Collecting Localities in the Conemaugh Series

Loc. 78.—Putnam Hill limestone, Tuscarawas County, Franklin Township (Navarre quadrangle). In the northeastern part of the township at the Sowder School crossroads at an elevation of 1066 feet. Collected by Henry Gray. *Fusulina leei.*

Loc. 79.—Lower Mercer and Upper Mercer limestones, Mahoning County, Berlin Township (Warren quadrangle). Outcrop of Upper Mercer limestone at an elevation of 1020 feet where Turkeybroth Creek enters Mill Creek in the western part of the township; Lower Mercer limestone about one-half mile farther west where the north-south road crosses Mill Creek. Collected by John Winslow. *Fusulinella iowensis* abundant in the Upper Mercer limestone and present in the Lower Mercer limestone.

Loc. 80.—Lower Mercer (?) limestone, Portage County, Shalersville Township (Ravenna quadrangle). Limestone exposed in new road cut of the Ohio Turnpike about one mile east of Shalersville. *Fusulinella iowensis* abundant. Collected by John Winslow.

Loc. 84.—Ames limestone, Athens County, Ames Township (Athens quadrangle), SE ¼, NW ¼, sec. 21. A ledge of massive limestone at 723 feet elevation along a gravel road one mile northeast of Route 50A. *Triticites skinneri.*

Loc. 87.—Upper Mercer limestone, Wayne County, Salt Creek Township (Millersburg quadrangle), center of eastern edge sec. 4. Limestone in ditch opposite T road intersection. Collected by H. G. Multer. *Fusulinella iowensis.*

Loc. 90.—Putnam Hill limestone, Wayne County, Franklin Township (Millersburg quadrangle), NW ¼, NW ¼, sec. 22. In abandoned quarry, elevation 1182 feet. Collected by H. G. Multer. *Fusulina leei.*

Loc. 91.—Putnam Hill limestone, Wayne County, Franklin Township (Millersburg quadrangle), SE ¼, SE ¼, sec. 10. Limestone in a ravine south of a farm house, at an elevation of 1150 feet. Collected by H. G. Multer. *Fusulina leei.*

Loc. 108—Ames limestone, Columbiana County, Madison Township (Wellsville quadrangle), NW ¼, NE ¼, sec. 21. Limestone in the road bank on the west side of Ohio Route 45 at the top of the hill. *Triticites skinneri* rare.

Loc. 109.—Lower Mercer limestone, Columbiana County, St. Clair Township (Wellsville quadrangle), north center sec. 12. Pieces of Lower Mercer float found in Bieler Run near its mouth and east of the railroad trestle. *Fusulinella iowensis* rare.

Loc. 110. Vanport limestone, Wayne County, Paint Township, (Millersburg quadrangle), NW ¼, NW ¼, sec. 18. In abandoned strip pit at elevation of 1232 feet. Collected by H. G. Multer. *Fusulina carmani.*

Loc. 115.—Lower Mercer limestone, Licking County, Hopewell Township (Thornville quadrangle). Limestone outcrop at the top of a knob in the southwest corner of the Township. Collected by George Franklin. *Fusulinella iowensis* abundant.

Loc. 116.—Portersville limestone, Athens County, Alexander Township (Athens quadrangle), SW ¼, NE ¼, sec. 30. Nodular limestone along road. Collected by M. T. Sturgeon and W. M. Merrill. *Triticites ohioensis* (?).

Loc. 117. Portersville limestone, Athens County, Alexander Township (Athens quadrangle), N ½, NE ¼, sec. 28 and S ½, SE ¼, sec. 29. Nodular limestone in ravine. Collected by M. T. Sturgeon and W. M. Merrill. *Triticities ohioensis* (?).

LITERATURE CITED

Alexander, R. D. 1954. Desmoinesian fusulinids of northeastern Oklahoma. Oklahoma Geol. Survey Cir. **31**: 67 pp.

Blake, O. D. 1952. Geology of Gallia County, Ohio. Unpublished dissertation. The Ohio State University, Columbus.

Condit, D. D. 1912. Conemaugh formation in Ohio. Ohio Geol. Survey Bull. 17: 366 pp.

Condra, G. E., E. C. Reed, and **O. J. Sherer.** 1940 Correlations of the formations of the

Laramie Range, Hartville uplift, Black Hills and western Nebraska. Nebraska Geol. Survey Bull. 13–A: 24–31.
Conrey, G. W. 1921. Geology of Wayne County. Ohio Geol. Survey Bull. 24: 155 pp.
Dunbar, C. O. 1933. Fusulinidae. Cushman Lab. Foram. Research Special Publ. 4: 126–140, pl. 13.
——— and **G. E. Condra.** 1927. The Fusulinidae of the Pennsylvanian system in Nebraska. Nebraska Geol. Survey 2nd S. 2: 135 pp.
——— and **L. G. Henbest.** 1930. The fusulinid genera *Fusulina*, *Fusulinella*, and *Wedekindella*. Amer. Jour. Sci. 5th S. 20: 357–365.
——— and ———. 1931. *Wedekindia*, a new fusulinid name. Amer. Jour. Sci. 5th S. 21: 458.
——— and ———. 1942. Pennsylvanian Fusulinidae of Illinois. Illinois Geol. Survey Bull. 67: 218 pp.
Gray, H. H. 1954. Stratigraphy and Sedimentation of Pottsville Rocks near Beach City, Ohio. Unpublished dissertation. The Ohio State University, Columbus.
Henbest, L. G. 1928. Fusulinellas from the Stonefort limestone member of the Tradewater formation. Jour. Paleont. 2: 70–85.
———. 1954. Pennsylvanian Foraminifera in Amsden formation and Tensleep sandstone, Montana and Wyoming. Billings Geol. Soc. Guidebook, 5th Ann. Field Conference, 1954: 50–53.
——— and **C. B. Read.** 1944. Stratigraphic distribution of the Pennsylvanian Fusulinidae in a part of the Sierra Nacimiento of Sandoval and Rio Arriba counties, New Mexico. U. S. Geol. Survey, Oil and Gas Investigations, Prelim. Chart 2.
Herrick, C. L. 1887. A sketch of the geologic history of Licking County, Ohio. Denison Univ. Sci. Bull. 2: 5–70, pl. 3, fig. 20.
Lamborn, R. E. 1930. Geology of Jefferson County. Ohio Geol. Survey Bull. 35: 304 pp.
Love, J. D., L. G. Henbest, and **N. M. Denson.** 1953. Stratigraphy and paleontology of Paleozoic rocks, Hartville area, eastern Wyoming. U. S. Geol. Survey, Oil and Gas Investigations, Chart OC 44.
Mark, Clara G. 1911. The Mercer limestone and its associated rocks in the Newark-Zanesville region. Denison Univ. Sci. Lab. Bull. 16: 267–314.
Moore, R. C., et al. 1944. Correlation of Pennsylvanian formations of North America. Geol. Soc. Amer. Bull. 55: 657–706.
Morningstar, Helen. 1922. Pottsville fauna of Ohio. Ohio Geol. Survey Bull. 25: 312 pp.
Multer, H. G. 1955. Stratigraphy, structure, and economic geology of Pennsylvanian rocks in Wayne County, Ohio. Unpublished dissertation. The Ohio State University, Columbus.
Myers, D. A., P. T. Stafford, and **R. J. Burnside.** 1956. Geology of the late Paleozoic Horseshoe Atoll in west Texas. Univ. Texas Bull. 5607: 133 pp.
Needham, C. E. 1937. Some New Mexico Fusulinidae. New Mexico School of Mines Bull. 14: 88 pp.
Northrop, S. A. and **G. H. Wood.** 1946. Geology of the Nacimiento Mountains, San Pedro Mountain, and adjacent plateaus in parts of Sandoval and Rio Arriba counties, New Mexico. U. S. Geol. Survey, Oil and Gas Investigations, Prelim. Map 57.
Skinner, J. W. 1931. New Permo-Pennsylvanian Fusulinidae from northern Oklahoma. Jour. Paleont. 5: 16–22, pls. 3–4.
Smyth, Pauline. 1951. Fusulinidae in the Pennsylvanian of Ohio (Ab.). Geol. Soc. Amer. Bull. 62: 1481.
Stout, W. 1918. Geology of Muskingum County. Ohio Geol. Survey Bull. 21: 351 pp.
———. 1927. Geology of Vinton County. Ohio Geol. Survey Bull. 31: 402 pp.
Teflian, S. 1952. A study of the Vanport limestone in the Oak Hill area, southern Ohio. Unpublished thesis. The Ohio State University, Columbus.
Thompson, M. L. 1934. The fusulinids of the Des Moines series of Iowa. Univ. of Iowa Stud. Nat. Hist. 16: 273–332, pls. 20–23.
———. 1935. Fusulinids from the Lower Pennsylvanian Atoka and Boggy formations of Oklahoma. Jour. Paleont. 9: 291–306, pl. 26.
———. 1936. Pennsylvanian fusulinids from Ohio. Jour. Paleont. 10: 673–683, pls. 90–91.
——— and **H. D. Thomas.** 1953. Systematic paleontology of fusulinids from the Casper formation. Wyoming Geol. Survey Bull. 46, pt. 2: 15–56.
———, **G. J. Verville,** and **H. J. Bissell.** 1950. Pennsylvanian fusulinids of the south-central Wasatch Mountains, Utah. Jour. Paleont. 24: 430–465, pls. 57–64.
de Verneuil, E. 1846. On the *Fusulina* in the Coal formation of Ohio. Amer. Jour. Sci. 2nd S. 2: 293.
Wanless, H. R. 1955. Pennsylvanian rocks of eastern interior basin. Amer. Assoc. Petrol. Geol. Bull. 39: 1753–1820
White, M. P. 1932. Some Texas Fusulinidae. Univ. Texas Bull. 3211: 1–104, pls 1–10.

A KEY TO THE NATIVE AND NATURALIZED CLIMBING PLANTS OF OHIO BASED UPON VEGETATIVE CHARACTERS[1]

H. R. DE SELM[2]

Department of Botany and Plant Pathology, The Ohio State University, Columbus 10

The first attempt to bring together a list of Ohio climbing plants is that of Dufour (1902) in which 77 species and varieties are cited. Since that time this group of plants has received no particular attention excepting the woody vines included in the keys of Schaffner (1928).

The present key brings together those climbing plants now known in the state and makes available their determination. Included are 100 species and varieties (the species of *Cuscuta* are not separated). The increase in number of taxa included reflects 1) the increase in our flora due to escapes, and 2) recognition of varieties by taxonomists.

Included are species and varieties, specimens of which are on deposit in the Herbarium of The Ohio State University, and in addition some species reported for Ohio in other collections. Excluded are most of the hundreds of species, varieties, and forms commonly planted but not known to have escaped and become a part of our flora. Certain exceptions to the above statement exist. *Cardiospermum halicacabum*, for example, is stated by Fernald (1950) to be an escape in our area although the only specimen in the O.S.U. Herbarium is one which persisted after cultivation in Highland County. Excluded also are taxa such as certain species of *Rosa* and *Galium* which, if reclining against upright objects, may extend several feet in height because of recurved thorns or bristles.

Several sources have been of aid in preparation of the key. Many descriptions and key characters are from the manuals of Schaffner (1928), Fernald (1950), and Gleason (1953). The *Vitis* key is drived essentially from that of Blackburn (1952). Nomenclature is essentially that of Fernald (1950).

Previously published keys to climbing plants are those of Newhall (1897), and Pepoon (1927). These keys employ reproductive as well as vegetative characteristics. Jennings (1907) included only commonly planted woody forms. The key constructed by Curtis in Hottes (1924, 1949) includes many horticultural taxa and like the present one is based upon vegetative characters. In general, if flowers are available, the standard regional manuals are as well employed.

KEY

1. Plant woody or somewhat so. 2.
1. Plant herbaceous. 47.
    2. Leaves opposite or whorled. 3.
    2. Leaves alternate. 19.
3. Leaves whorled, ovate, acuminate. *Cynanchum nigrum.*
3. Leaves opposite. 4.
    4. Leaves simple. 5.
    4. Leaves compound. 15.
5. Stem with aerial roots or tendrils. 6.
5. Stem twining. 8.
    6. Aerial roots present. *Schizophragma hydrangioides*
    6. Tendrils present. 7.

[1]Publication 613, Department of Botany and Plant Pathology, The Ohio State University.
[2]Present address, Botany Department, University of Tennessee, Knoxville, Tennessee.

7. Leaves obtusely lobed at summit, lobes entire, petiole without glands. *Passiflora lutea*
7. Leaves 3–5 cleft, lobes serrate, petiole with 2 glands. *Passiflora incarnata*
8. Leaves cordate or subcordate. 9.
8. Leaves ovate or rounded. 10.
9. Leaves hirsute. *Gonobolus obliquus*
9. Leaves nearly smooth. *Cynanchum nigrum*
10. Leaves distinct. *Lonicera japonica*
10. Some of upper leaves connate. 11.
11. Leaves remotely strigose-pilose above. *Lonicera hirsuta*
11. Leaves glabrous above. 12.
12. Connate upper leaves broader than long. *Lonicera prolifera*
12. Connate upper leaves longer than broad. 13.
13. Leaves glabrous beneath. *Lonicera dioica*
13. Leaves pubescent or minutely pilose beneath. 14.
14. Leaves minutely pilose beneath. *Lonicera sempervirens*
14. Leaves pubescent beneath. *Lonicera dioica* var. *glaucescens*
15. With tendrils. *Bignonia capreolata*
15. Tendrils absent. 16.
16. Climbing by rootlets. *Campsis radicans*
16. Climbing by coiling petioles. 17.
17. Leaves with 3–7 leaflets, bright green, entire or 2–3 lobed. *Clematis viorna*
17. Leaves with 3–5 leaflets, usually toothed and lobed. 18.
18. Leaves and shoots usually clustered at nodes of older growth. *Clematis verticillaris*
18. Leaves and shoots not so clustered. *Clematis virginiana*
19. Leaves compound or decompound. 20.
19. Leaves simple. 27.
20. Leaves digitate, plant with tendrils. 21.
20. Leaves pinnate, biternate, or decompound. 22.
21. Leaves 5-foliate. *Parthenocissus quinquefolia*
21. Leaves 3-foliate, or 3-lobed. *Parthenocissus tricuspidata*
22. Leaves biternate, or otherwise decompound. *Cardiospermum halicacabum*
22. Leaves pinnate. 23.
23. Leaves odd-pinnate, leaflets 9–19. 24.
23. Leaves trifoliate. 25.
24. Leaflets 9–15. *Wisteria frutescens.*
24. Leaflets usually 15–19. *Wisteria floribunda*
25. Plants with aerial roots. *Rhus radicans*
25. Plants not as above. 26.
26. Leaves ovate to subrotund, 10–15 cm. long, lobed. *Pueraria lobata*
26. Leaves ovate to ovate-lanceolate, not lobed. *Clitoria mariana*
27. Woody twiners. 28.
27. Plants with aerial roots or tendrils. 31.
28. Leaves serrulate. *Celastrus scandens*
28. Leaves lobed or entire. 29.
29. Leaves peltate. *Menispermum canadense*
29. Leaves not eltate. 30.
30. Leaves entire, short-petioled, oblong to ovate, acuminate, rounded to subcordate at base. *Cynanchum nigrum*
30. Leaves usually with 1–2 basal and either divergent or deflexed lobes. *Solanum dulcamara*
31. With rootlets. *Hedera helix*
31. With tendrils. 32.
32. Tendrils with adhesive disks. *Parthenocissus tricuspidata*
32. Tendrils without disks. 33.

33. Older branches with woody partitions at leaf nodes. 34.
33. Branches not with woody partitions. 39.
34. Under leaf surface with a felt-like layer of rusty brown hairs. *Vitis labrusca*
34. Under leaf surface not so covered. 35.
35. Leaves densely woolly-hairy beneath when young, remaining so especially along the veins. 36.
35. Leaves pubescent or not, but not densely woolly-hairy beneath. 37.
36. Leaves coarsely toothed and mostly prominently and deeply 3–5 lobed. *Vitis aestivalis*
36. Leaves dentate or shallowly toothed and lobed. *Vitis cinerea*
37. Leaves conspicuously whitish or bluish-white beneath. *Vitis aestivalis* var. *argentifolia*
37. Leaves light or grey-green beneath. 38.
38. Leaves coarsely and sharply toothed, indistinctly lobed. *Vitis vulpina*
38. Leaves more or less toothed and strongly lobed. *Vitis riparia*
39. Leaves not lobed, broad ribbed, and net-veined. 40.
39. Leaves lobed. 44.
40. Leaves strongly whitened beneath. *Smilax glauca*
40. Leaves green or nearly so beneath. 41.
41. Peduncles shorter than petioles. *Smilax rotundifolia*
41. Peduncles longer than petioles. 42.
42. Prickles weak and pliant, terete, leaves with thin margins. *Simlax tamnoides* var. *hispida*
42. Prickles hard and rigid, broad based. 43.
43. Leaves thick-coriaceous and hard, with thickened margins. *Smilax bona-nox*
43. Leaves submembranaceous to thin-coriaceous, margins not thickened. *Smilax rotundifolia*
44. Leaves obtusely lobed at summit, lobes entire. *Passiflora lutea*
44. Lobes serrate. 45.
45. Petiole with 2 glands. *Passiflora incarnata*
45. Petiole without glands. 46.
46. Plant nearly glabrous, leaves serrate and obscurely lobed. *Ampelopsis cordata*
46. Plant pubescent, leaves serrate and obviously 3–lobed. *Ampelopsis brevipedunculata*
47. Plant pale or white, leaves reduced to minute scales. *Cuscuta* spp.
47. Plant green. 48.
48. Leaves opposite or whorled. 49.
48. Leaves alternate, sometimes the basal whorled. 63.
49. Leaves in whorls. 50.
49. Leaves opposite. 52.
50. Leaves cordate-ovate with concave sides. *Dioscorea batatas*
50. Leaves similar, with convex sides. 51.
51. Leaves deeply cordate and long-petioled. *Dioscorea villosa*
51. Leaves ovate, base rounded to subcordate, short-petioled. *Cynancnum nigrum*
52. Leaves commonly compound, leaflets 3–7. 53.
52. Leaves simple. 54.
53. Stem six angled. *Clematis viorna*
53. Stem not so. *Clematis virginiana*
54. Plant with tendrils. 55.
54. Plant without tendrils. 56.
55. Leaves 3–cleft, lobes serrate, petiole with 2 glands. *Passiflora incarnata*
55. Leaves obtusely lobed at summit, lobes entire. *Passiflora lutea*
56. Plant harshly scabrous. 57.
56. Plant not so. 58.
57. Principle leaves 3–lobed, yellow resinous-dotted beneath. *Humulus lupulus*
57. Principle leaves 5–7 lobed, not dotted beneath. *Humulus japonicus*

58. Leaves hirsute, abruptly acuminate. *Gonobolus obliquus*
58. Leaves smooth, or pubescent beneath. 59.
59. Stem six angled. *Clematis viorna*
59. Stem no so. 60.
60. Leaves cordate-ovate, with concave sides. *Dioscorea batatas*
60. Leaf margins convex. 61.
61. Leaves short-petioled. *Cynanchum nigrum*
61. Leaves long-petioled. 62.
62. Veins palmate, 7–11, prominent, not conspicuously branched. *Dioscorea villosa*
62. Veins pinnate, branches not prominent. *Ampelamus albidus*
63. Leaves simple. 64
63. Leaves compound. 95.
64. Plant with tendrils, or if without, narrowly to broadly ovate. 65.
64. Plant twining; or erect, later declined. 72.
65. Leaves not lobed. 66.
65. Leaves lobed. 69.
66. Plant erect, mostly without tendrils. *Smilax ecirrhata*
66. Plant climbing. 67.
67. Leaves glabrous beneath. *Smilax herbacea*
67. Leaves puberulent on veins beneath. 68.
68. Leaves short acuminate. *Smilax pulverulenta*
68. Leaves rounded, blunt, or short cuspidate. *Smilax lasioneura*
69. Leaves 3–5 cleft, lobes serrate. *Passiflora incarnata*
69. Leaves lobed, but not conspicuously serrate. 70.
70. Leaves lobed at summit, lobes entire. *Passiflora lutea*
70. Leaves palmately 5–lobed. 71.
71. Uppermost 2 sinuses acute. *Sicyos angulatus*
71. Uppermost 2 sinuses obtuse. *Echinocystis lobata*
72. Stem erect, later declined. *Convolvulus spithamaeus*
72. Stem twining. 73.
73. Leaves with an ocreae. 74.
73. No ocreae present. 76.
74. Ocreae reflexed-bristly at base. *Polygonum cilinode*
74. Ocreae smooth. 75.
75. Leaves hastate to triangular-cordate. *Polygonum convolvulus*
75. Leaves oblong-ovate, ovate, or broadly cordate. 76.
76. Leaf sinus usually narrow. *Polygonum scandens*
76. Leaf sinus usually broad. *Polygonum cristatum*
77. Leaves toothed. *Ipomea coccinea*
77. Leaves not so. 78.
78. Leaves pinnately divided. *Ipomea quamoclit*
78. Leaves not so. 79.
79. Leaves prominently veined. 80.
79. Leaves not prominently veined. 81.
80. Leaves cordate-ovate with concave sides. *Dioscorea batatas*
80. Leaves similar but sides convex. *Dioscorea villosa*
81. Petiole short, leaves oblong to ovate, acuminate, rounded to subcordate at base. *Cynanchum nigrum*
81. Petiole relatively long. 82.
82. Leaves prominently lobed, lateral lobe(s) separated from the terminal by a deep sinus. 83.
82. Leaves not as above. 85.
83. Lateral lobes small, 1–2. *Solanum dulcamara*
83. Lateral lobes approaching the terminal in size. 84.
84. Plant pubescent. *Ipomea hederacea*
84. Plant glabrous. *Ipomea coccinea*

85. Leaves ovate to cordate-ovate in general outline. 86.
85. Leaves triangular in general outline. 89.
86. Stem pubescent. *Ipomea purpurea*
86. Stem glabrous or only slightly pubescent. 87.
87. Leaves short-acuminate to apiculate. *Ipomea lacunosa*
87. Leaves acuminate. 88.
88. Leaves cordate-hastate. *Ipomea coccinea*
88. Leaves cordate, the lobes rounded or angled. *Ipomea pandurata*
89. Leaves sagittate. 90.
89. Leaves hastate. 92.
90. Leaf tips rounded, apiculate to obtuse. *Convolvulus arvensis*
90. Leaf tips acuminate, sometimes acute. 91.
91. Basal leaf lobes obtuse or rounded. *Convolvulus sepium* var. *repens*
91. Basal leaf-lobes with 1–3 conspicuous but scarcely acute angles. *Convolvulus sepium*
92. Basal lobes not angled, terminal usually oblong. 93.
92. Basal lobes angled. 94.
93. Tip rounded, obtuse or apiculate. *Convolvulus arvensis*
93. Tip acute. *Convolvulus japonicus*
94. Terminal lobe oblong. *Convolvulus japonicus*
94. Terminal lobe tapered to tip. 95.
95. Sinus of leaf V or U-shaped with sloping or divergent sides. *Convolvulus sepium*
95. Sinus of leaf quadrangular, sides nearly parallel. *Convolvulus sepium* var. *fraterniflorus*
96. Stipules absent. 97.
96. Stipules present. 100.
97. Plant with tendrils on corymbs. *Cardiospermum halicacabum*
97. Plant without tendrils. 98.
98. Plant climbing by young leafstalk. *Adlumia fungosa*
98. Plant twining. 99.
99. Leaf pinnately divided to midrib. *Ipomea quamoclit*
99. Leaf trifoliate. *Galactia volubilis*
100. Leaflets lobed. 101.
100. Leaflets not lobed. 102.
101. Stem more or less retrorsely pubescent. *Strophostyles helvola*
101. Stem glabrous. *Pueraria lobata*
102. Leaves trifoliate. 103.
102. Leaves with tendrils at end of rachis. 111.
103. Stem glabrous. 104.
103. Stem pubescent. 105.
104. Leaflets deltoid-ovate. *Dolichos lablab*
104. Leaflets ovate to ovate-lanceolate. *Clitoria mariana*
105. Leaflets ovate, rounded or apiculate. *Galactia volubilis*
105. Leaflets oblong, rhombic-ovate, or ovate, acute or acuminate. 106.
106. Leaflets oblong to narrow-ovate. 107.
106. Leaflets ovate or rhombic-ovate. 108.
107. Leaflets grey-silky pubescent. *Strophostyles leiosperma*
107. Leaflets glabrous to strigose-pilose beneath. *Strophostyles umbellata*
108. Stem and petiole densely villous-hirsute. *Amphicarpa bracteata* var. *comosa*
108. Pubescence less abundant. 109.
109. Veinlets uniting conspicuously near leaf margin. *Phaseolus polystachios*
109. Veinlets not as above. 110.
110. Leaflets rhombic-ovate. *Amphicarpa bracteata*
110. Leaflets ovate. *Strophostyles helvola*
111. Leaflets one pair. 112.
111. Leaflets 2 or more pairs. 114.

112. Stem winged. *Lathyrus latifolius*
112. Stem wingless. 113.
113. Stipules 1–2 cm. long, about equalling petiole, linear-lanceolate to narrowly elliptic. *Lathyrus pratensis*
113. Stipules 5–12 mm. long, oblanceolate to elliptic. *Lathyrus tuberosus*
114. Stem winged. 115.
114. Stem wingless. 117.
115. Leaves linear. *Lathyrus palustris* var. *linearifolius*
115. Leaves elliptic. 116.
116. Stem stout, 1.5–3.0 mm. in diameter below lowest peduncle, leaflets 2–5 pairs, 3.0–8.5 cm. long. *Lathyrus palustris*
116. Stem slender, .5–1.5 mm. in diameter below lowest peduncle, leaflets 2–3(–5) pairs, 1.5–3.5 cm. long. *La hyrus palustris* var. *myrtifolius*
117. Stipules large, near leaflet size. 118.
117. Stipules small. 119.
118. Stipules symmetrical. *Lathyrus japonicus* var. *parviflorus*
118. Stipules not symmetrical. *Lathyrus ochroleucus*
119. Stem more or less villous throughout. 120.
119. Stem not villous. 121.
120. Stem spreading villous. *Vicia villosa*
120. Stem appressed pubescent or glabrate. *Vicia dasycarpa*
121. Leaflets 2–6 pairs, 2–6 cm. long usually elliptic. 122.
121. Leaflets smaller, or if not, the stipules serrate. 124.
122. Leaflets 2–3 pairs, elliptic to lanceolate, 2–4.5 cm. long. *Lathyrus palustris* var. *myrtifolius*
122. Leaflets 5–6 pairs, elliptic to ovate, 1.5–6.5 cm. long. 123.
123. Stipules of larger leaves ovate-lanceolate, 2–3.5 cm. long. *Lathyrus venosus*
123. Stipules of the larger leaves linear-lanceolate, .8–2.0 cm. long, plant hirtellous. *Lathyrus venosus* var. *intonsus*
124. Stipules serrate. 125.
124. Stipules not serrate. 128.
125. Leaflets 5–14 mm. broad. 126.
125. Leaflets 1–4 mm. broad. 127.
126. Lateral leaf veins prominent in drying. *Vicia americana*
126. Lateral veins not as above. *Vicia sativa*
127. Upper leaflets mucronate. *Vicia angustifolia*
127. Upper leaflets emarginate or apiculate. *Vicia sativa* var. *linearis*
128. Lower stipular lobes with setiform segments. *Vicia hirsuta*
128. Stipules entire (some semisagittate). 129.
129. Leaflets glabrate to silky, stem striate-angled. *Vicia cracca*
129. Leaflets glabrous, stem smooth. 130.
130. Leaflets 2–5 pairs. *Vicia tetrasperma*
130. Leaflets 6–12 pairs. *Vicia caroliniana*

REFERENCES

Blackburn, B. 1952. Trees and Shrubs in Eastern North America. Oxford Univ. Press. New York.
Dufour, A. 1902. Climbing plants of Ohio. Ohio Nat. 2: 197–200.
Fernald, M. L. 1950. Gray's Manual of Botany. Eight edition. American Book Co. New York.
Gleason, H. A. 1952. Illustrated Flora of the Northeastern United States and adjacent Canada. 3 vols. The New York Botanical Garden. New York.
Jennings, O. E. 1907. A descriptive key to the woody climbing plants commonly cultivated in Ohio. Jour. Columbus Hort. Soc. 22: 20–46.
Hottes, A. C. 1924. A Little Book of Climbing Plants. De La Mare Co. New York.
———. 1949. Climbers and Ground Covers. De La Mare Co. New York.
Newhall, C. S. 1897. The Vines of Northeastern America. Putnam's Sons. New York.
Pepoon, H. S. 1927. An Annotated Flora of the Chicago Area. Natural History Survey Bull. 8. The Chicago Academy of Sciences. Chicago.
Schaffner, J. A. 1928. Field Manual of the Flora of Ohio. R. G. Adams and Co. Columbus, Ohio.

STUDIES IN OHIO BRYOPHYTES[1]

ROBERT M. GIESY
University College of North Wales, Bangor, Wales

Ohio is recognized by bryologists as a state for which the bryophyte flora is well collected and well known. This is not without foundation, for the enthusiasm of both amateurs and professionals in collecting has stimulated many scattered reports. Most reports are of specific areas within the state but several have dealt with the entire state. In spite of the large number of collections and reports, there has not yet been a comprehensive study of the bryophyte flora of this state. It is especially appropriate that such a study not be delayed since comparisons of the vegetation of the state 20 and 30 years ago with the vegetation of today will reveal that industrial and urban expansion have made great inroads upon the natural vegetation. Commercial enterprises are now moving en masse to this region, and as Ohio becomes an even greater industrial state it is easily foreseeable that vegetation and natural beauty may be quickly supplanted by factory architecture.

During recent studies of the distribution of Ohio mosses, the author had the opportunity of examining approximately 9500 packets of Ohio moss collections. Primary effort was placed upon examining those packets which were in herbaria within or near Ohio. Lists of species collected in Ohio were obtained from various national herbaria and published reports dealing with the state were also consulted. The check list presented herein is a result of this study.

BRIEF HISTORY OF BRYOLOGY IN OHIO

The Period before 1900

This era was dominated by the interest and enthusiam of the father of American bryology, William S. Sullivant. Sullivant became interested in mosses about the year 1840. Although his first publication on Ohio plants in 1840 contained no mention of mosses, he was to issue in 1845 an accurately identified collection, the *Musci Allegheniense*. Prior to Sullivant's collection, the published moss flora of the state consisted of nine species mentioned in the catalogue of John C. Riddel. The supplement to this catalogue listed two more species (Riddel, 1835, 1836). Mr. T. G. Lea accumulated collections of the Cincinnati region during the years 1834 to 1844. This list of 88 species was not published until 1849, after Lea's death. It was published by Sullivant. The *Musci Allegheniense* contained 25 species listed as from Ohio and 52 species listed as common, a total of 77 species which the present author infers were known from Ohio.

Sullivant's early interest in mosses probably led him to investigate the vicinity of Columbus thoroughly. In a letter to Gray, written in 1841, he states, "Our locality here is not a good one for mosses—at least we have not those that affect hilly or mountainous districts—there may be found here with close hunting perhaps 130 to 140 species" (Rogers, 1940). In the foreword to the bryophyte section of Gray's Manual, second edition, 1856, Sullivant states, "Scarcely any portion of our country, excepting central Ohio, has been carefully examined." The Manual contains 44 species listed as from Ohio and 95 listed as common, a total of 139. Lesquereux and James' *Mosses of North America*, published in 1884, was meant to be the fulfillment of Sullivant's work. It contained 42 species listed as from Ohio and 145 species listed as common.

[1]Paper from the Department of Botany and Plant Pathology, The Ohio State University, No. 602.

Sullivant's enthusiasm was undoubtedly influential in stimulating the interest of contemporary Ohio collectors. In 1854, Mr. J. L. Cassels published a list of six mosses from the vicinity of Cleveland. In a later publication (1874) he lists mosses collected in this vicinity from 1845 to 1859. In 1878, Mr. A. P. Morgan published *Flora of Miami Valley*, which listed six mosses. Collections during this period include those of the Reverend Mr. Herzer of Berea, Ohio, whose specimens are now in the Baldwin Wallace College Herbarium, and those of F. D. Kelsey, then chairman of the department of botany at Oberlin College, whose collections are now in the Oberlin College Herbarium. Miss Hannah J. Biddlecome and Miss E. Jane Spence, both from Springfield, Ohio, collected extensively in the areas of Cedar Swamp and Clifton Gorge. Their collections are scattered throughout herbaria in Ohio, but the majority are in The Ohio State University Herbarium. Wm. C. Werner, collecting mostly from Franklin County, also contributed to The Ohio State University Herbarium. Many specimens from various collectors of this period have the notation upon them "from Prof. Lesquereux." Leo Lesquereux was Sullivant's assistant during his lifetime and it is apparent that Lesquereux continued to inspire Ohio bryologists after Sullivant's death. That a good contact was maintained between bryologists is evidenced by the abundance of material that was exchanged between Claassen, Beardslee, Lesquereux, Biddlecome, Spence and others of this period.

Collections and publications near the year 1900 include those of Beardslee and Claassen. Dr. H. C. Beardslee (1865–1948), a retired teacher who lived in Painesville, Ohio, collected extensively in that area. His well preserved and mounted specimens are now a part of The Ohio State University Herbarium. In 1877 Beardslee published a catalogue which contains a list of 261 mosses reported from Ohio. This list was based upon previous lists published by Sullivant, upon his own collections, and upon specimens reported by Leo Lesquereux. Mr. Edo Claassen (1834–1933), a druggist from Cleveland, published several lists of mosses of the region near Cleveland, Ohio. Many of his specimens are now at Western Reserve University in a memorial collection. Others, particularly the mosses, are a part of The Ohio State University Herbarium.

In 1893 Kellerman and Werner published a list of Ohio plants which contained 267 Ohio mosses based largely on Beardslee's catalogue and Werner's collections.

Collections since 1900

Recent collections have been stimulated by the interest in bryology of the botanists at several institutions and many collections are those of organized classes. Typical collections of this type are those at Ohio Wesleyan University. The interest in byology at Ohio Wesleyan was due to the enthusiasm of Dr. C. E. O'Neal, chairman of the botany department from 1913 to 1954.

Individual collectors prominent during this period include representatives from all areas of the state. Dr. Victor Sterki (1846–1933), a physician from Switzerland, came to this country in 1883 and lived in New Philadelphia, Ohio. He was for a time associated with the Carnegie Museum which houses his moss collection of the New Philadelphia area. Miss Nellie Henderson published a list of mosses of Ohio with descriptions and keys during the years 1925 to 1931. This work was based upon the specimens then on deposit in The Ohio State University Herbarium. C. H. Coles in an unpublished Masters Thesis lists all the known mosses of Franklin County as of the date 1933. His specimens are a part of The Ohio State University Herbarium.

There are a number of persons now actively interested in the moss flora of Ohio. Among these, the foremost is Dr. R. C. Wareham, now living in Massachusetts. His accurately determined collections compose the bulk of The Ohio State University moss herbarium. Dr. Wareham collected intensively and extensively over the state from 1939 to 1942. His contribution to Ohio bryology

is outstanding. Mr. Alman Rood of Phalanx Station, Ohio, has assembled a personal collection of bryophytes of the region in and around Mahoning and Trumbull Counties. The team of Bartley and Pontius is well known and respected among Ohio naturalists. Leslie Pontius was assistant postmaster in Circleville, Ohio. Floyd Bartley is a farmer near Circleville. Together they collected extensively in Highland, Jackson, Pickaway, Hocking, and Scioto Counties. These two men are credited with the discovery of many new records of Ohio mosses. Pontius' collection is now at Ohio University at Athens, while Bartley retains and is still adding to his large personal collection. Irma Schnooberger and Frances Wynne collected the moss flora of the Lake Erie Islands in 1945. Duplicates of their collection are in the herbarium of the Stone Biological Laboratory, Put-In-Bay, Ohio. Wood County was investigated in 1950 by R. W. Emmit, then a student at Bowling Green State University. His specimens are at Bowling Green. Dr. Margaret Fulford has assembled a personal collection, largely of Adams County. These specimens are at the University of Cincinnati. Maurice B. Walters (1952) published a list of mosses of the Cleveland area and continues to collect in this area. Harold Robinson (1957), now at the University of Tennessee, conducted an intensive investigation of Athens County mosses in 1955. His specimens are at Ohio University.

DISTRIBUTIONAL STUDIES

The geologic and vegetational history of Ohio is complex but fairly well understood. An understanding of the factors contributing to the present day aspect and composition of Ohio vegetation demands consideration of such things as the Pre-Pleistocene vegetation (Braun, 1934, 1950), The Teays River System (Ver Steeg, 1946), Pleistocene vegetation (Sears, 1930), Lake Tight (Tight, 1903; Transeau, 1941; Wolfe, 1940), and the extension of the western grasslands into Ohio (Transeau, 1935).

The results of such a vegetational and geologic history leaves Ohio a complex mosaic of forest types in which one would expect to find the following elements:

1. An element from the Tertiary flora which persisted throughout the Pleistocene.
2. An element from the southern Appalachian Mountains which was afforded a northward migration route via the cliffs and valleys of the Teays river system.
3. A northern element which preceded the glacier as it advanced southward.
4. A western element which can be correlated with the advance of the Prairie into Ohio.

Subsequent papers will deal in detail with the distribution and affinities of Ohio mosses. For the present, an inspection of the following list will reveal that no western element has yet been discovered in the Ohio moss flora but that there is a coastal plain element, a northern element, and a tropical element, based upon the geographical affinities as listed by Sharp (1939).

AN ANNOTATED LIST OF SPECIES OCCURRING IN OHIO

The following list, containing 331 species within 121 genera and 34 families, was compiled as a result of the aforementioned study and represents a complete list of all species collected from Ohio to date.

The county records are based primarily upon specimens on deposit in The Ohio State University Herbarium and supplemented when necessary by records from other herbaria. Abbreviations used after the county name indicate that records are based upon specimens in other herbaria, as follows:

OB	Oberlin College	UC	University of Cincinnati
BW	Baldwin Wallace College	SL	Stone Biological Laboratory
OW	Ohio Wesleyan University	C	Carnegie Museum
OU	Ohio University	M	Marietta College

County records not followed by any of the above abbreviations are a part of The Ohio State University Herbarium.

Additional small collections which the author was unable to examine are known to exist at the following institutions:

Ohio Wesleyan University	Carnegie Museum
Dennison University	Marietta College
University of Cincinnati	Bowling Green State University

Identifications were based primarily upon descriptions and illustrations in *Moss Flora of North America*, edited by A. J. Grout. It was also necessary to refer frequently to Jennings, *Bryologia Europea*, Sullivant, Engler and Prantl, *North American Flora* and other standard bryological references. Grout's exsicatti were freely used for comparisons. The arrangement of all taxa is that of Grout (1940).

Andreaeaceae

Andreaea rothii Web. and Mohr. On wet sandstone. Fairfield; Hocking.
Andrea rupestris Hedw. On moist sandstone. Hocking.

Tetraphidaceae

Tetraphis pellucida Hedw. On rotting logs, shale banks, bare sandstone cliffs, soil. Ashtabula; Athens, OU; Auglaize, BW; Belmont; Champaign, UC; Coshocton; Cuyahoga, BW; Erie, Ob; Fairfield; Franklin, BW; Hocking; Jackson, OU, C; Lake; Lawrence; Licking; Lorain, Ob; Monroe; Portage, OU; Summit, C; Trumbull; Vinton.

Polytrichaceae

Atrichum angustatum (Brid.) Bry. Eur. On soil in exposed or unexposed places, usually in damp woods. Ashtabula, C; Athens, OU; Auglaize; Carroll; Columbiana; Coshocton, C; Cuyahoga, BW; Darke; Delaware, OW; Erie; Fairfield; Franklin, BW; Gallia; Geauga; Guernsey; Hardin; Highland; Hocking; Jackson, OU; Lake; Lawrence; Licking; Lorain, Ob; Lucas; Mahoning; Meigs; Morgan, OU; Noble; Ottawa, SL; Pike; Portage; Richland; Scioto; Seneca; Shelby; Stark; Trumbull; Tuscarawas, C; Vinton, OU; Washington, BW, M; Wood, BG.

Atrichum crispum (James) Sull. Base of moist sandstone cliff. Jackson.

Atrichum macmillani (Holz.) Frye. On sandstone. Licking; Wood, BG.

Atrichum undulatum (Hedw.) Beauv. On soil usually in wet areas such as stream banks; also on humus in moist woods. Ashtabula; Athens, OU; Auglaize; Belmont; Clark; Clinton; Coshocton; Cuyahoga; Darke; Delaware, OW; Erie, Ob; Fairfield; Franklin; Gallia; Hamitlon; Hancock; Henry; Highland; Hocking; Jackson, OU; Lake; Logan; Lorain, Ob; Meigs, OU; Monroe; Montgomery; Morgan, OU; Ottawa, SL; Perry; Portage; Richland; Scioto; Shelby; Stark; Trumbull; Tuscarawas, C; Union; Van Wert; Vinton; Warren, UC; Washington, BW, M; Williams; Wood, BG.

Pogonatum brachyphyllum (Rich.) Beauv. On exposed clay banks. Hocking.

Pogonatum pensilvanicum (Hedw.) Paris. On exposed clay banks; i.e., stream banks, especially in woods on exposed soil at base of fallen trees. Adams, UC; Athens, OU; Belmont; Coshocton; Cuyahoga, BW; Delaware, OW; Fairfield; Franklin, BW; Geauga; Hocking; Holmes; Jackson, OU; Lake; Lawrence; Licking; Lorain, Ob; Meigs; Perry; Richland; Ross; Stark; Vinton, OU.

Polytrichum commune Hedw. On soil in moist areas, woods, stream banks. Ashtabula; Athens, OU; Belmont; Coshocton; Cuyahoga, BW; Geauga; Harrison; Hocking; Jackson, OU; Lake; Licking; Lorain, Ob; Lucas; Portage; Scioto; Trumbull; Vinton, OU; Williams; Wood, BG.

Polytrichum gracile Smith. Damp soil in woods. Fairfield, BW; Summit.

Polytrichum juniperinum Hedw. On soil usually in dry exposed areas. Ashtabula; Athens, OU; Champaign; Coshocton; Cuyahoga, BW; Fairfield, OU; Geauga, Ob; Hardin; Hocking; Lake; Licking; Lucas; Monroe; Portage; Richland, Ob; Trumbull; Vinton, OU; Wayne.

Polytrichum ohioense Ren. and Card. On soil or rocks, near tree bases, usually in open woods. Adams, UC; Ashland; Ashtabula; Athens, OU; Belmont; Clark; Columbiana; Coshocton; Crawford; Cuyahoga, BW; Defiance; Delaware; Fairfield; Franklin; Geauga; Hamilton; Highland; Hocking; Holmes; Jackson, OU; Knox; Lake, OU; Lawrence; Licking; Lorain, Ob; Lucas; Meigs, OU; Monroe; Morgan; Portage; Preble; Richland; Ross; Scioto; Seneca; Stark; Summit; Trumbull; Tuscarawas; Vinton, OU; Washington, M; Williams; Wood, BG.

Polytrichum piliferum Hedw. Dry exposed areas such as cliff tops. Athens, OU; Fairfield; Geauga; Hocking; Jackson; Licking; Lorain, Ob; Portage; Trumbull; Vinton, OU.

Fissidentaceae

Bryoxiphium norvegicum (Brid.) Mitt. Vertical sandstone cliffs. Athens, OU; Fairfield, BW; Hocking, OU; Jackson, OU; Licking; Portage; Scioto; Vinton, OU.

Fissidens adiantoides Hedw. In wet boggy areas. Ashtabula; Champaign; Cuyahoga; Highland, OU; Jackson, OU; Lake; Lawrence, Ob; Ottawa, SL, C; Ross, OU.

Fissidens cristatus Wils. On soil in wooded areas, base of trees, swampy area. Adams; Athens, OU; Belmont; Butler, UC; Champaign; Clark; Delaware; Franklin; Highland, OU; Hocking; Jackson, OU; Lawrence; Lucas; Meigs; Muskingum; Ottawa, SL; Pickaway, OU; Ross, OU; Stark; Washington, M.

Fissidens exiguus Sull. Moist areas sometimes inundated. Athens; Franklin, BW; Highland.

Fissidens exilis Hedw. On bare patches of ground in woods. Cuyahoga.

Fissidens garberi Lesq. & Janes. On moist sandstone, roof of sandstone caves. Hocking; Jackson.

Fissidens hallianus (Sull. & Lesq.) Mitt. On sandstone bed of intermittent creek. Hocking; Wood, BG.

Fissidens julianus (Mont.) Schimp. On stones in running streams. Clermont, UC; Franklin, BW; Highland, OU; Portage; Seneca; Trumbull.

Fissidens minutulus Sull. On moist sandstone, occasionally on wet clay or limestone. Adams; Athens, OU; Clark; Cuyahoga; Delaware; Fairfield; Franklin, BW; Hamilton; Hocking; Jackson; Lake; Meigs; Miami; Ottawa, SL; Perry; Ross, OU; Trumbull; Washington, M.

Fissidens obtusifolius Wils. On soil, limestone cliffs and sandstone in moist areas. Adams; Clark; Cuyahoga, C; Erie, SL; Franklin, BW; Lorain, Ob; Ottawa, SL; Trumbull; Washington; Wood, BG. Reported from Hamilton (Lea), Hocking (L & J), Greene (Sull.) and from Pennsylvania border at Smith's Ferry (Jenn.).

Fissidens osmundioides Hedw. On soil, moist rocks in shaded areas. Adams, UC; Athens, OU; Belmont; Champaign; Delaware, OW; Erie, Ob; Hocking; Jackson, OU; Lake; Lorain, Ob; Mahoning; Meigs; Ottawa, SL; Ross, OU; Summit, C; Tuscarawas, C; Wood, BG.

Fissidens subbasiliaris Hedw. Soil, tree bases, rotten logs, limestone cliffs. Adams; Champaign; Clark; Cuyahoga; Highland, OU; Hocking; Miami; Scioto; Van Wert.

Fissidens taxifolius Hedw. Usually on damp soil in shaded areas occasionally on decayed logs, tree bases and wet cliffs. Adams, UC; Athens, OU; Champaign; Clermont, UC; Coshocton; Cuyahoga, C; Delaware, OW; Franklin; Hamilton; Hocking, OU; Jackson, OU; Lake; Miami; Monroe; Morrow; Ottawa; Ross; Scioto; Shelby; Trumbull; Vinton; Williams; Wood. Specimen from Hamilton County in Sullivant herbarium not seen.

Fissidens viridulus (Webb & Mohr.) Wahlenb. Moist sandstone cliffs. Adams; Coshocton.

Archidiaceae

Archidium ohioense Schimp. In fields, meadows, bare places. One specimen in Sullivant's collection, one specimen from Lesquereux at Ohio State University.

Ditrichaceae

Bruchia flexuosa (Sw.) C. Mull. In fields among grasses. Fairfield; Franklin, BW; Ross.

Bruchia sullivanti Aust. On bare soil, along paths, in fields among grasses. Belmont; Hocking, OU; Jackson; Lorain, Ob; Lucas; Ross.

Ceratodon purpureus (Hedw.) Brid. Widespread, usually in dry situations, cliff edges, trees, paths, rocks, open areas. Ashtabula; Athens, OU; Belmont; Carroll; Clark; Clermont, UC;

Clinton, UC; Columbiana; Coshocton; Cuyahoga, BW; Darke; Defiance; Delaware; Erie, SL; Fairfield; Franklin; Greene; Guernsey; Hamilton, UC; Hardin; Hocking; Holmes; Huron; Jackson, OU; Lake; Lawrence; Licking; Logan; Lorain, Ob; Lucas; Mahoning; Mercer; Miami; Morrow; Ottawa, SL; Paulding; Perry; Pickaway, OU; Portage; Richland; Ross; Sandusky; Seneca; Shelby; Stark, OU; Summit; Trumbull; Washington, M; Williams; Wood, BG.

Ditrichum lineare (Sw.) Lindb. On moist sand or sandstone in open, bare areas. Athens, OU; Clark; Jackson, OU; Pike; Trumbull.

Ditrichum pallidum (Hedw.) Hampe. On bare soil in open areas. Adams, UC; Ashland; Athens, OU; Belmont; Clark; Clermont, UC; Clinton, UC; Coshocton; Delaware, OW; Franklin; Greene; Hamilton, UC; Hocking, OU; Jackson, OU, C; Lake; Lawrence, Ob; Licking; Noble; Pike; Richland; Scioto; Stark; Trumbull; Tuscarawas; Van Wert; Vinton, OU; Washington, M; Williams; Wood, BG.

Ditrichum pusillum (Hedw.) E. G. Britton. Open sandy or clay banks and ditches. Belmont; Clermont, UC; Cuyahoga; Fairfield; Hamilton, UC; Highland; Jackson; Lake; Lucas; Ottawa, SL; Ross; Trumbull; Washington, M.

Trematodon longicollis MX. On gravel bank. Hocking; Pike.

Pleuridium acuminatum Lindb. In open areas, cliff tops, fields, on soil among grasses. Franklin, BW; Hocking; Jackson; Ross. Specimen from Cuyahoga County reported by Henderson, not seen.

Pleuridium subulatum (Hedw.) Lindb. On moist open soil, in fields among grasses. Adams, UC; Athens, OU; Clinton, UC; Cuyahoga; Fairfield; Franklin, BW; Hamilton, UC; Hocking; Jackson; Logan; Lorain, Ob; Pickaway; Pike; Richland; Ross, OU; Scioto; Trumbull; Tuscarawas, C.

Seligeriaceae

Seligeria calcarea (Hedw.) Bry. Eur. On wet limestone rocks. Erie. Reported in Grout as from near Columbus, Ohio. Specimen not seen.

Seligeria campylopoda Kind. On damp shaded rocks. Erie.

Seligeria pusilla (Hedw.) Bry. Eur. Usually on moist vertical stone cliffs. Scioto. Reported from Erie and Logan Counties by Henderson. Specimens not seen.

Dicranaceae

Brothera leana (Sull.) C. Mull. On moist sandstone cliffs, occasionally on rotten logs. Athens, OU; Fairfield; Hocking; Jackson; Pike. Reported as collected by C. Purpus in Auglaize County, December, 1891, specimen not seen, and by T. G. Lea as from Cincinnati, Sull. Mus. All. #172.

Campylopus flexuosus Brid. On sandstone cliff faces. Jackson, OU; Pike.

Campylopus introflexus (Hedw.) Brid. On rock in dry exposed area mixed with *P. piliferum*. Jackson. Only one specimen. Det. R. T. Wareham, fide A. J. Grout.

Dichodontium pellucidum (Hedw.) Schimp. On stones in creek. Ashtabula.

Dicranella heteromalla (Hedw.) Schimp. On moist banks, usually on soil in shaded places. Ashtabula; Athens; Clark; Clermont, UC; Columbiana; Coshocton; Cuyahoga, BW; Delaware, OW; Erie, SL; Fairfield; Franklin; Geauga; Guernsey; Hamilton, UC; Hocking; Jackson, OU, C; Lake; Lawrence; Licking; Lorain, Ob; Mahoning; Monroe; Morrow; Ottawa, SL; Pickaway; Portage, C; Richland; Ross, OU; Scioto; Shelby; Stark; Summit; Trumbull; Tuscarawas, C; Vinton; Wood, BG.

Dicranella rufescens (Smith) Schimp. On moist bare soil. Ashtabula; Coshocton; Cuyahoga; Delaware, OW; Hocking; Lake, Ob; Washington, BW.

Dicranella schreberi (Hedw.) Schimp. On limestone rock. Ross, OU. One specimen, collected by Bartley, fide A. J. Grout.

Dicranella varia Hedw.) Schimp. Usually on clay banks, occasionally on limestone rocks. Adams; Ashtabula; Athens, OU; Brown, UC; Clark; Clermont, UC; Cuyahoga, BW; Delaware, OW; Erie, SL; Franklin, BW; Geauga; Hamilton, UC; Highland, OU; Lake; Licking; Lorain; Ottawa, SL; Pickaway, OU; Ross, OU; Van Wert; Washington, M.

Dicranodontium denudatum (Brid.) E. G. Britton. On rocks, cliffs in shady moist spots. Fairfield; Hocking, OU; Jackson, OU; Madison; Portage.

Dicranum bonjeani Denot. On soil, rocks, decaying wood in forested regions. Belmont; Highland; Jackson; Portage.

Dicranum condensatum Hedw. Dry wooded areas, cliff tops. Adams, UC; Athens, OU; Hocking; Jackson, OU; Pike; Ross.

Dicranum drummondii C. Mull. In wooded areas usually in moist situations. Adams; Ashtabula; Clark; Coshocton; Fairfield; Hocking; Jackson; Pike; Portage; Ross; Scioto; Trumbull; Wood.

Dicranum flagellare Hedw. Usually on rotten wood, occasionally on moist rock faces. Adams, UC; Belmont; Champaign; Clark; Coshocton; Cuyahoga; Delaware, OW; Fairfield; Franklin; Hamilton, UC; Jackson, OU; Lake; Lorain, Ob; Montgomery; Pickaway, OU; Portage; Richland; Ross, OU; Trumbull; Washington. Reported recently from Athens County by Robinson.

Dicranum fulvum Hook. Exclusively on rocks, usually on cliff faces. Ashtabula; Athens, OU; Belmont; Columbiana; Coshocton; Cuyahoga; Fairfield; Franklin; Guernsey; Highland, OU; Hocking; Holmes, BW, OU; Jackson, OU; Logan; Meigs, OU; Monroe; Ottawa, SL; Portage; Richland; Ross, OU; Scioto; Summit; Trumbull; Vinton.

Dicranum fuscescens Turn. Base of trees and decayed wood. Cuyahoga; Delaware, OW; Jackson, OU; Logan; Vinton, OU; Washington, M.

Dicranum montanum Hedw. Trees and tree bases, occasionally on stones. Adams; Ashland; Ashtabula, C; Athens, OU; Champaign; Coshocton; Darke; Delaware, OW; Fairfield; Highland; Hocking; Jackson, OU; Portage; Richland; Vinton, OU; Wood, BG.

Dicranum rugosum (Hoffm.) Brid. In dry open woods. Adams, UC; Fairfield; Franklin, BW; Highland; Hocking; Jackson, OU; Ross.

Dicranum scoparium Hedw. On soil, rocks, decaying wood in forested regions. Adams, UC; Ashland; Ashtabula, C; Athens, OU; Champaign; Clermont, UC; Clinton, UC; Coshocton; Cuyahoga, BW; Delaware, OW; Fairfield; Franklin; Gallia; Guernsey; Hamilton, UC; Hocking; Holmes, BW; Jackson, OU, C; Knox; Lake; Lawrence; Licking; Logan; Lorain, Ob; Lucas; Meigs, OU; Monroe; Morgan, OU; Pickaway; Pike; Richland; Ross, OU; Scioto; Trumbull; Tuscarawas, C; Vinton, OU; Warren, UC; Washington, M; Williams; Wood, BG.

Dicranum spurium Hedw. On open, dry areas such as cliff tops, pine woods. Adams, UC; Athens, OU; Fairfield; Franklin; Hocking; Jackson, OU.

Dicranum viride (Sull. & Lesq.) Lindb. On tree bases, tree roots and rotten logs. Adams, UC; Ashtabula, C; Brown, UC; Butler, UC; Champaign; Clark; Clermont, UC; Coshocton; Fairfield; Franklin; Hocking; Jackson; Lake; Lorain, Ob; Monroe; Morrow; Portage; Richland; Scioto; Williams.

Paraleucobryum longifolium (Hedw.) Loeske. On rocks, rarely on trees. Tuscarawas, C.

Rhabdoweisia denticulata (Brid.) Bry. Eur. On sandstone cliffs, occasionally on soil. Athens, OU; Hocking; Jackson, OU; Lawrence; Pike; Portage.

Leucobryaceae

Leucobryum albidum (Brid.) Lindb. On soil and rocks in open places. Ashtabula; Athens, OU; Champaign; Hocking; Lawrence. Reported from Sandusky County by Beardslee, specimen not seen.

Leucobryum glaucum (Hedw.) Schimp. On soil and rocks, usually in open, dry, woodlands. Adams, UC; Ashtabula, C; Athens, OU; Champaign; Clermont, UC; Clinton, UC; Coshocton; Cuyahoga; Delaware, OW; Fairfield; Franklin; Fulton; Gallia; Geauga; Guernsey; Hamilton, UC; Hocking; Holmes; Jackson; Lake; Licking; Lorain, Ob; Lucas; Mahoning; Meigs, OU; Pike; Portage, OU; Richland; Ross; Scioto; Seneca; Stark; Summit; Trumbull; Vinton; Washington; Wood, BG.

Calymperaceae

Syrrhopodon texanus Sull. On moist sandstone cliffs. Hocking; Jackson, OU; Pike.

Encalyptaceae

Encalypta ciliata Hedw. On soil. Ottawa, C.

Encalypta streptocarpa Hedw. On limestone cliffs or soil over limestone. Adams; Greene; Highland, OU.

Buxbaumiaceae

Buxbaumia aphylla Hedw. On dry, open, hillsides, usually on humus. Fairfield; Holmes; Lake.

Diphyscium foliosum (Hedw.) Mohr. On hillsides in wooded areas, usually on soil. Adams, UC; Athens, OU; Belmont; Coshocton; Cuyahoga, BW; Fairfield; Franklin, BW; Geauga; Hocking; Holmes, BW; Jackson; Licking; Monroe; Morgan, OU; Portage; Ross, OU; Scioto.

Pottiaceae

Acaulon rufescens Jaeger. On bare soil in open fields. Athens; Pickaway.

Astomum ludovicianum Sull. On bare open soil. Athens, OU.

Astomum muhlenbergianum (Sw.) Grout. On soil in open fields. Highland; Hocking; Licking; Pickaway; Ross; Scioto. Reported recently from Athens County by Robinson.

Barbula fallax Hedw. On soil in open areas. Highland, OU; Lake; Montgomery; Ottawa, SL; Pickaway, OU; Washington, BW.

Barbula reflexa (Brid.) Brid. On limestone, cliffs, bridge abuttments, etc. Adams; Champaign.

Barbula unguiculata Hedw. On bare soil, in pastures, roadside banks, plowed areas. Adams, UC; Athens, OU; Clermont, UC; Cuyahoga, C, BW; Delaware, OW; Erie, SL; Franklin; Geauga; Hamilton, UC; Highland, OU; Hocking; Lake; Licking; Lorain, Ob; Lucas; Montgomery; Morrow; Ottawa, SL; Paulding; Pickaway, OU; Ross, OU; Shelby; Tuscarawas, C; Van Wert; Washington, M; Wood, BG; Wyandot.

Desmatodon cernuus (Huben) Bry. Eur. On calcareous soil. Highland, OU.

Desmatodon obtusifolius (Schwaegr.) Jur. On sandstone cliffs, cement bridge abuttments. Adams; Ashtabula; Athens, OU; Clark; Cuyahoga; Fairfield; Highland, OU; Hocking, BW; Jackson, OU; Lake; Licking; Ottawa, SL; Pickaway, OU; Richland; Ross, OU; Summit; Trumbull; Union; Vinton.

Desmatodon porteri James. Face of moist limestone rocks. Adams, UC; Athens, OU; Clark; Franklin; Highland; Ottawa, SL; Scioto; Shelby; Washington, M; Wood, BG.

Didymodon recurvirostris (Hedw.) Jennings. Moist places in the open, usually on rocks. Champaign; Cuyahoga; Delaware, OW; Erie, SL, C; Lorain, Ob; Ottawa, SL, C; Union.

Didymodon rigidulus Hedw. Growing on moist rocks. Ottawa, SL; Wood, BG.

Didymodon tophaceus (Brid.) Jur. In crevices of limestone cliffs. Adams; Shelby; Wood.

Didymodon trifarius (Hedw.) Brid. On calcareous soil or rocks. Ottawa, SL, C.

Eucladium verticillatum (Brid.) Bry. Eur. Wet limestone rocks. Ross.

Gymnostomum aeruginosum Smith. On face of moist limestone or shale cliffs. Adams; Ashland; Athens, OU; Belmont; Clark; Erie, SL; Greene; Hocking; Ottawa, SL; Ross; Shelby; Trumbull.

Gymnostomum calcareum Nees & Hornsch. On moist limestone cliffs, occasionally on sandstone. Adams, UC; Cuyahoga; Erie, SL; Franklin; Highland; Hocking; Lake; Lawrence; Monroe; Ottawa, SL; Ross; Scioto; Shelby; Summit; Trumbull.

Gymnostomum recurvirostrum Hedw. On moist limestone or shale cliffs. Adams, UC; Belmont; Clark; Cuyahoga, BW; Delaware; Erie; Franklin; Greene; Highland, OU; Hocking, BW; Lake; Logan; Lorain; Mahoning; Ottawa, SL; Ross; Shelby; Trumbull.

Hyophila tortula (Schwaegr.) Hampe. On rocks in streams or on moist cliffs. Adams; Ashtabula; Clark, C; Erie, SL; Geauga; Greene; Ottawa, SL.

Phascum cuspidatum Hedw. On moist soil in open fields. Athens, OU; Franklin; Ottawa, SL; Pickaway; Ross.

Pottia truncata (Hedw.) Furn. On soil. Trumbull.

Tortella humilis (Hedw.) Jennings. On soil, rocky banks, around tree bases in wooded areas or in the open. Adams, UC; Athens, OU; Butler, UC; Champaign, UC; Clark; Clermont, UC;

Coshocton; Erie, SL; Fairfield; Greene; Hamilton, UC; Highland, OU; Hocking, OU; Jackson; Lake; Ottawa, SL, C; Ross; Scioto; Shelby; Vinton, OU; Washington, M; Wood, BG.

Tortella tortuosa (Turn.) Limpr. On sandstone and limestone. Highland, OU; Hocking; Ottawa, SL.

Tortula intermedia Brid. On calcareous rocks. Ottawa.

Tortula mucronifolia Schwaegr. On calcareous rocks. Cuyahoga; Ottawa, SL.

Tortula pagorum (Milde) Denot. On trees in open areas. Adams; Pickaway; Ross, OU.

Tortula papillosa Wils. On trees in open areas, occasionally on rocks. Adams; Champaign; Clark; Fayette; Franklin; Greene; Guernsey; Licking; Madison; Morrow; Pickaway; Ross; Union.

Tortula ruralis (Hedw.) Smith. On dry soil in open areas. Erie; Ottawa, SL, C; Wyandot, OU.

Trichostomum cylindricum (Bruch.) C. Mull. Face of moist cliffs. Hocking; Jackson, OU; Ottawa, SL.

Weisia tortilis (Schwaegr.) C. Mull. Crevices in limestone cliffs. Adams.

Weisia viridula Hedw. On bare soil, usually among grasses. Adams, UC; Athens, OU; Belmont; Clark; Coshocton, BW; Cuyahoga, BW; Delaware, OW; Erie; Fairfield; Franklin; Hamilton, UC; Highland; Hocking; Holmes; Jackson, OU; Lawrence; Licking; Lorain, Ob; Madison; Montgomery; Morgan, OU; Ottawa, SL; Pike; Portage; Richland; Ross; Scioto; Shelby; Union; Vinton.

Grimmiaceae

Campylostelium saxicola (Web & Mohr.) Bry. Eur. On exposed sandstone cliffs. Gallia; Pickaway, OU; Scioto; Washington, M.

Grimmia alpicola Hedw. On rocks that are occasionally inundated. Ashtabula; Ottawa, SL; Portage; Trumbull.

Grimmia apocarpa Hedw. On exposed rock surfaces. Athens, OU; Coshocton; Cuyahoga, C, BW, M; Erie, SL; Franklin, OU; Highland, OU; Hocking; Lorain, Ob; Ottawa, C, SL; Paulding; Pickaway, OU; Ross, OU; Trumbull; Van Wert; Washington, M; Wood, BG. Variety *conferta* reported from Lake County by Beardslee, specimen not seen.

Grimmia olneyi Sull. On exposed rocks. Vinton, OU.

Grimmia pilifera Beauv. On dry exposed rocks. Hocking; Jackson; Lawrence; Scioto. Reported by Jennings from Lake County, specimen not seen.

Grimmia pulvinata (Hedw.) Smith. On dry rocks. Ottawa, SL.

Hedwigia ciliata On rocks in many different situations. Athens, OU; Belmont; Butler; Clark; Coshocton; Cuyahoga, BW; Darke; Delaware; Fairfield; Franklin, OU; Geauga; Hocking; Holmes; Jackson, OU; Lake; Lawrence; Lorain, Ob; Meigs; Monroe, BW; Morgan, OU; Ottawa, SL; Pickaway, OU; Portage; Richland; Ross, OU; Scioto; Shelby; Summit; Vinton; Washington, M; Wood, BG.

Ptychomitrium incurvum (Muhlenb.) Sull. On exposed sandstone rocks. Athens, OU; Hocking; Jackson, OU; Pickaway; Ross, OU.

Rhacomitrium heterostichum (Hedw.) Brid. On rocks in moist places. Fairfield; Hocking, Pike.

Ephemeraceae

Ephemerum cohaerens (Hedw.) Hampe. On soil in swampy area. Ross.

Ephemerum crassinervium (Schwaegr.) C. Mull. On soil in open fields. Adams; Franklin; Gallia; Hamilton, UC; Hocking; Jackson.

Ephemerum serratum (Hedw.) Hampe. On soil in open fields. Cuyahoga; Hocking; Jackson; Ross.

Ephemerum spinulosum Schimp. On soil in wet meadows. Athens, OU; Hocking; Ross.

Nanomitrium austinii (Sull.) Lindb. On moist bare soil. Jackson; Pike.

Nanomitrium synoicum (James) Lindb. On moist, bare soil. Jackson.

Disceliaceae

Discelium nudum (Dicks.) Brid. On exposed clay banks. Cuyahoga; Delaware; Holmes; Knox, OU; Lake, Ob; Lorain, Ob.

Funariaceae

Aphanorhegma patens (Hedw.) Lindb. On soil in fields, river banks, paths. Fairfield; Franklin; Licking; Pickaway; Ross.

Aphanorhegma serratum (Hook & Wils.) Sull. On soil stream banks, old fields. Athens, OU; Brown, UC; Clermont, UC; Franklin, BW; Gallia; Hamilton, UC; Highland; Hocking; Jackson; Licking; Meigs, OU; Pickaway; Richland; Ross.

Funaria flavicans MX. On moist soil. Adams, UC; Athens, OU; Coshocton; Fairfield; Franklin; Hamilton, UC; Highland, OU; Hocking; Jackson, OU; Lawrence; Pike.

Funaria hygrometrica Hedw. Moist soil, burned over areas, especially old ash heaps and cinder piles. Adams, UC; Ashtabula; Athens, OU; Butler; Champaign, UC; Clark; Coshocton; Cuyahoga; Erie, SL, Ob; Fairfield; Franklin; Fulton; Gallia; Geauga; Greene; Hamilton, UC; Lake; Licking; Logan; Lorain, Ob; Lucas; Muskingum; Ottawa, SL, Ob; Perry; Pickaway; Pike; Portage; Preble; Richland; Ross, OU; Shelby; Stark; Summit; Trumbull; Union; Washington, M; Wood, BG.

Physcomitrium immersum Sull. On moist soil. Cuyahoga; Geauga; Lake. Reported from southern Ohio by Lea in Lesquereux & James and Sull. Icones.

Physcomitrium turbinatum (MX.) Brid. On bare soil in open fields. Adams; Ashtabula, C; Athens, OU; Belmont; Champaign; Clark; Clermont, UC; Clinton, UC; Columbiana; Coshocton; Cuyahoga; Erie, SL; Franklin; Hamilton, UC; Hardin; Hocking; Jackson, OU; Lake; Lawrence; Logan; Lorain, Ob; Lucas; Meigs, OU; Montgomery; Morgan, OU; Ottawa, SL, C; Pickaway; Pike; Richland; Scioto; Shelby; Trumbull; Tuscarawas, C; Washington, M; Wood, BG; Wyandot.

Schistostostegaceae

Schistostega pennata (Hedw.) Hook & Tayl. Soil or rocks in dimly lighted areas such as roofs or floors of caves. Geauga. Reported from Portage County by Claassen, specimen not seen.

Orthotrichaceae

Amphidium californicum (Hampe) Broth. Face of wet cliffs, ceiling of caves. Hocking, OU; Jackson.

Amphidium lapponicum (Hedw.) Schimp. Face of wet cliffs. Hocking, OU; Jackson.

Amphidium mougeotii (Bry. Eur.) Schimp. Moist, shaded cliff faces. Hocking; Jackson, OU.

Drummondia prorepens (Hedw.) Jennings. On bark of trees. Adams; Athens, OU; Auglaize, BW; Clark; Cuyahoga; Fairfield; Franklin; Greene; Hamilton, UC; Highland, OU; Hocking; Lake; Lorain, Ob; Madison; Monroe, BW; Perry; Pickaway, OU; Ross; Scioto; Shelby.

Orthotrichum anomalum Hedw. On limestone. Ottawa, SL, C; Ross.

Orthotrichum elegans Hook & Grev. On trees. Highland; Lake.

Orthotrichum garrettii Grout & Flowers. On granite boulders. Franklin.

Orthotrichum lescurii Aust. On limestone or granite rocks. Pickaway; Shelby.

Orthotrichum obtusifolium Brid. On trees. Lake; Sandusky.

Orthotrichum ohioense Sull. & Lesq. On trees. Adams; Delaware; Franklin, BW; Greene; Highland; Hocking; Jackson; Lake; Pickaway; Ross; Scioto; Vinton; Washington, M; Wood, BG.

Orthotrichum pumillum Dicks. On trees. Champaign; Clark; Delaware; Franklin; Hardin; Hocking; Lake; Licking; Logan; Madison; Morrow; Pickaway; Richland; Ross; Sandusky; Shelby; Union; Vinton; Washington, M; Wood, BG.

Orthotrichum pusillum Mitt. On trees. Madison; Scioto.

Orthotrichum stellatum Brid. On trees. Adams; Athens, OU; Clark; Fairfield; Franklin; Highland, OU; Hocking; Jackson, OU; Lake; Licking; Logan; Miami; Morgan; Morrow; Pickaway, OU; Ross; Scioto; Vinton, OU.

Orthotrichum strangulatum Schwaegr. On trees. Adams; Athens, OU; Delaware; Franklin, BW, OU; Greene; Highland, OU; Pickaway; Ross; Scioto; Shelby; Wood, BG.

Orthotrichum sordidum Common on trees. Specimen from Lesquereux, no data given.

Ulota americana (Beauv.) Limpr. On sandstone boulders. Cuyahoga; Hocking; Holmes, SL; Jackson, OU; Lake.

Ulota crispa (Hedw.) Brid. On trees. Ashtabula; Athens, OU; Cuyahoga; Fairfield; Greene; Highland; Hocking; Jackson, OU; Lake; Lorain, Ob; Monroe; Pickaway; Ross; Scioto; Vinton; Washington, M.

Ulota ludwigii Brid. On trees in the open. Lake.

Zygodon viridissimus (Dicks.) R. Br. Crevices of moist sandstone rock. Jackson.

Timmiaceae

Timmia megapolitana Hedw. On moist soil. Clark; Delaware; Franklin; Hocking; Pickaway, OU.

Aulocomniaceae

Aulocomnium heterostichum (Hedw.) Bry. Eur. On soil and humus in moist woodlands, stream banks and hillsides. Adams, UC; Allen; Ashtabula, C; Athens, OU; Champaign; Clark; Coshocton; Delaware, OW; Fairfield; Franklin; Fulton; Highland, OU; Hocking; Jackson, OU; Lake; Lawrence; Licking; Lorain, Ob; Lucas; Meigs; Monroe; Portage; Ross, OU; Scioto; Shelby; Summit; Trumbull; Vinton; Washington, M; Wood, BG.

Aulocomnium palustre (Web & Mohr.) Schwaegr. In swamps and bogs. Adams, UC; Ashtabula, C, Athens, OU; Champaign; Cuyahoga; Delaware, OW; Gallia; Geauga; Hocking; Jackson, OU; Lake, OU; Licking, OU; Lorain, Ob; Morrow; Ottawa, SL; Pickaway, OU; Portage, OU; Richland; Stark; Summit, C; Trumbull; Tuscarawas, C; Warren, UC; Williams; Wood, BG.

Bartramiaceae

Bartramia pomiformis Hedw. On soil and rocks of cliff faces and steep banks in moist situations. Adams, UC; Athens, OU; Belmont; Champaign; Clark; Coshocton; Cuyahoga, BW; Delaware, OW; Fairfield, BW; Franklin; Highland; Hocking; Holmes; Jackson, OU; Lake; Lawrence; Lorain, Ob; Lucas; Meigs; Monroe; Noble; Pickaway; Pike; Portage; Ross, OU; Scioto; Tuscarawas, C; Vinton; Washington, BW, M.

Philonotis caespitosa Wils. On soil and wet rocks in moist shaded situations. Jackson; Licking.

Philonotis fontana (Hedw.) Brid. On wet shale or sandstone. Ashtabula; Cuyahoga; Fairfield; Geauga; Hamilton, UC; Hocking; Jackson, OU; Lake; Licking; Lorain, Ob; Mahoning; Wood, BG.

Philonotis longiseta (Rich.) E. G. Britton. On moist soil near streams. Athens, OU; Hocking.

Philonotis marchica (Willd.) Brid. In wet situations, swamps, sandstone cliffs. Champaign; Hocking, BW; Trumbull. Reported from Lake County by Beardslee, specimen not seen.

Meesiaceae

Meesia longiseta Hedw. Deep swamps and sphagnum bogs. One specimen from Lesquereux with no data. Also #161 in Musc. Bor. Amer. Ed. I, 1856.

Bryaceae

Bryum argenteum (L.) Hedw. On soil, rocks, in dry situations such as sidewalks, bricks, ash piles. Athens, OU; Clark; Coshocton; Cuyahoga, C; Delaware, OW; Erie, SL; Fairfield; Franklin; Hamilton, UC, OU; Hocking; Jackson; Lake; Lorain, Ob; Morgan, OU; Ottawa, SL, C; Pickaway; Pike; Portage; Shelby; Summit, C; Trumbull; Tuscarawas, C; Union; Van Wert; Washington, M; Wood, BG.

Bryum bicolor Dicks. On sandy soil in moist situations. Athens, OU.

Bryum caespiticum (L.) Hedw. On soil, in paths and bare areas. Adams; Ashtabula, C; Athens, OU; Champaign, UC; Clark; Clinton, UC; Cuyahoga, BW; Erie, SL, C; Fairfield; Franklin; Hardin; Highland, OU; Hocking; Lake; Lorain, Ob; Lucas, Ob; Mahoning; Mercer; Ottawa, SL, C; Pickaway, OU; Shelby; Summit; Union; Williams; Wood, BG.

Bryum capillare (L.) Hedw. On stones, soil, tree bases, humus. Athens, OU; Coshocton; Cuyahoga, BW; Erie, SL; Franklin; Hardin; Highland; Hocking; Jackson, OU; Miami; Morgan, OU; Perry; Pickaway; Portage; Ross, OU; Scioto; Vinton, OU; Washington, M; Williams.

Bryum cuspidatum (Bry. Eur.) Schimp. On soil or rocks in wet places. Adams, UC; Athens; Carroll; Champaign, UC; Clark; Columbiana; Cuyahoga; Erie, SL; Franklin; Greene; Jackson; Lake; Licking; Lorain, Ob; Monroe; Ottawa, SL; Ross; Stark; Washington, M; Wood, BG.

Bryum pseudo triquetrum (Hedw.) Schwaegr. In wet swampy places on rocks and soil. Athens, OU; Brown, UC; Butler, UC; Carroll; Champaign, UC; Clark; Cuyahoga, BW; Erie, SL; Franklin, BW; Hamilton, UC; Hancock; Highland; Hocking; Jackson, OU; Lorain, Ob; Mahoning; Ottawa, SL; Portage; Richland; Ross, OU; Washington, M.

Bryum tortifolium Funck. In crevices in moist limestone. Shelby.

Bryum uliginosum (Brid.) Bry. Eur. Clark; Lake; Summit. Reported from Lake County by Beardslee, no specimen seen.

Leptobryum pyriforme (Hedw.) Schimp. Soil, humus, a "weed" in greenhouses. Adams; Ashland; Athens, OU; Clark; Cuyahoga, BW, C; Erie, SL; Franklin; Hardin; Hocking; Jackson, OU; Lake; Lorain, Ob; Ottawa, C. SL; Pickaway; Ross, OU; Shelby; Summit; Washington, M.

Pohlia annotina (Hedw.) Loeske. On moist sandstone. Hocking; Jackson; Trumbull.

Pohlia elongata Hedw. On humus over rocks. Columbiana; Geauga. Reported by Claassen for Lake County, not seen.

Pohlia nutans (Hedw.) Lindb. On soil, humus, rocks in various situations. Athens, OU; Belmont; Clinton, UC; Columbiana; Coshocton; Cuyahoga; Delaware, OW; Fairfield; Franklin; Hocking; Jackson, OU; Lake; Logan; Lorain, Ob; Ottawa, SL; Pickaway, OU; Portage; Richland; Ross, OU; Summit, BW; Trumbull; Vinton; Wood, BG. Reported from Licking County by Claassen, not seen.

Pohlia wahlenbergii (Web & Mohr.) Andrews. Moist ledges, swamps, bogs. Adams; Ashtabula; Athens, OU; Butler; Champaign; Clark; Clermont, UC; Coshocton; Cuyahoga; Fairfield; Geauga; Hamilton, UC; Hocking; Jackson, OU; Lake; Lawrence; Meigs; Ottawa, SL; Ross, OU; Shelby; Trumbull; Wood, BG.

Rhodobryum roseum (Bry. Eur.) Limpr. In shaded places, on moist soil, humus, decaying logs. Ashtabula, C; Athens, OU; Champaign; Clark; Coshocton; Cuyahoga; Delaware, OW; Fairfield; Franklin; Geauga; Hamilton, UC; Henry; Highland, OU; Hocking; Lake; Lorain, Ob; Lucas; Meigs; Monroe, BW; Ottawa, SL; Perry; Pickaway; Vinton, OU; Warren, UC; Wood, BG. Reported from Summit County by Claassen, not seen.

Mniaceae

Mnium affine Bland. Soil, stones, logs, humus in all varieties of moisture and light conditions. Adams, UC; Ashtabula, C; Athens, OU; Auglaize; Belmont; Brown, UC; Carroll; Champaign; Clark; Clermont, UC; Coshocton; Cuyahoga; Delaware, OW; Erie, Ob; Fairfield; Franklin; Gallia; Hamilton, UC; Hocking; Jackson, OU, C; Lake; Lawrence; Licking; Lorain, Ob; Perry; Pickaway; Portage; Richland; Ross, OU; Scioto; Trumbull; Vinton; Warren, UC; Washington; Wayne; Wood, BG.

Mnium cuspidatum Hedw. On soil and humus, in woods, very common. Adams, UC; Athens, OU; Ashtabula; Auglaize, BW; Belmont; Brown, UC; Carroll; Champaign; Clark, C; Clermont, UC; Clinton, UC; Columbiana; Coshocton; Crawford; Cuyahoga, BW, C; Delaware, OW; Erie; Fairfield; Franklin, OU; Greene; Guernsey; Hamilton, UC; Hardin; Highland, UC, OU; Hocking; Holmes; Jackson, OU; Lake; Licking; Logan; Lorain; Madison; Meigs, OU; Mercer; Miami; Monroe; Montgomery; Morgan, OU; Morrow; Ottawa, C; Pickaway, OU; Richland; Scioto; Seneca; Shelby; Stark; Summit, C; Trumbull; Tuscarawas, C; Union; Van Wert; Vinton; Warren; Washington, BW; Williams; Wood, BG; Wyandot. Reported from Portage County by Claassen, not seen.

Mnium drummondii Bry. Eur. On wet rocks. Jackson, OU.

Mnium hornum Hedw. On soil at base of sandstone cliffs. Hocking; Jackson, OU, C; Lake; Portage.

Mnium longirostrum Brid. In moist places on soil and rocks, usually in woods. Adams; Clark; Fairfield; Franklin; Lake; Ottawa; Wood.

Mnium medium Bry. Eur. On wet soil in wooded areas. Ashtabula, C; Hamilton, UC; Lorain, Ob.

Mnium punctatum Hedw. On rocks, logs, soil in moist shaded situations. Ashtabula; Athens, OU; Belmont; Coshocton; Cuyahoga; Erie, SL; Fairfield, UC; Hocking; Jackson, OU; Meigs, OU; Monroe; Ottawa, SL; Richland; Ross, OU; Scioto; Summit, C; Trumbull; Wayne.

Mnium serratum Brid. On wet rocks, usually in shaded areas. Adams; Ashtabula; Athens; Hocking; Jackson; Monroe; Ross; Trumbull.

Mnium spinulosum Bry. Eur. On moist sandstone. Belmont; Lake; Monroe; Trumbull.

Mnium stellare Hedw. On rock, bark, decayed logs in forested areas. Butler, UC; Clark; Franklin; Hocking; Lorain, Ob; Monroe.

Hypnaceae

Amblystegiella confervoides (Brid.) Loeske. On limestone rocks. Adams; Clark; Delaware; Greene; Lorain, Ob; Ottawa, SL; Washington, M; Wood, BG.

Amblystegiella subtilis (Hedw.) Loeske. On tree bases. Franklin, BW; Hocking; Monroe; Wood, BG.

Amblystegium compactum (C. Mull.) Austin. On limestone and shale at the base of cliffs in either moist or dry conditions. Belmont; Highland; Ross, OU; Shelby. Reported from Cuyahoga County by Claassen, not seen.

Amblystegium juratzkanum Schimp. On soil, rotten wood, sandstone and limestone in slightly to very moist situations. Ashland; Champaign; Clark; Delaware, OW; Erie, Ob; Franklin, BW; Geauga; Lorain, Ob; Ottawa; Paulding; Portage; Richland; Trumbull; Wood, BG; Wyandot.

Amblystegium serpens (Hedw.) Bry. Eur. Usually on rotten logs but also on sandstone, dolomite and tree bark in shaded moist areas. Adams; Ashtabula, C; Athens, OU; Coshocton; Cuyahoga; Delaware, OW; Erie, SL; Franklin, S, BW; Highland, OU; Lorain, Ob; Mercer; Montgomery; Ottawa, SL; Richland; Seneca; Tuscarawas, C; Union; Vinton; Wood, BG. Reported by Claassen from Lake, Portage and Summit Counties, not seen.

Amblystegium varium (Hedw.) Linb. On almost every type of substrate and in a variety of habitats. Adams; Athens, OU; Belmont; Clark; Columbiana; Coshocton; Cuyahoga, BW; Defiance; Delaware, OW; Erie; Fairfield; Franklin, OU; Fulton; Greene; Hardin; Highland, OU; Hocking; Jackson, OU; Lawrence; Licking; Logan; Lorain; Madison; Mahoning; Meigs; Mercer; Miami; Monroe; Montgomery; Morgan, OU; Morrow; Ottawa, BW; Paulding; Pickaway, OU; Richland; Ross, OU; Scioto; Shelby; Stark; Trumbull; Tuscarawas; Union; Van Wert; Washington; Wayne; Williams; Wood, BG; Wyandot.

Bryacythecium acutum (Mitt.) Sull. In marshes or on stones in creeks. Ashtabula, C; Champaign; Clark; Coshocton; Holmes; Lake; Ottawa, SL; Pickaway; Ross, OU; Scioto; Van Wert.

Bracythecium campestre Bry. Eur. Among grasses on soil or stones, usually in moist areas. Athens; Franklin; Portage; Ross; Tuscarawas.

Bracythecium digastrum C. Mull & Kindb. On rocks. Ottawa, SL.

Bracythecium flagellare (Hedw.) Jennings. On soil or humus in moist wooded areas often on rocks in streams. Ashland; Ashtabula; Belmont; Coshocton; Fairfield; Hocking; Jackson; Monroe; Portage; Scioto; Trumbull.

Bracythecium flexicaule Ren. & Card. On rocks or soil on moist banks. Athens, OU; Franklin; Portage; Ross; Tuscarawas.

Bracythecium oxycladon (Brid.) Jaeger. & Sauerb. Base of trees, moist rocks, occasionally on soil. Adams; Athens, OU; Auglaize; Belmont; Clark, C; Coshocton; Fairfield; Franklin; Geauga; Greene; Guernsey; Highland, OU; Hocking; Holmes; Jackson; Lake; Licking; Mercer; Monroe; Ottawa, SL, C; Pickaway, OU; Richland; Scioto; Shelby; Tuscarawas, C; Wood, BG.

Bracythecium rivulare Bry. Eur. In wet areas on rocks or soil, swamps, edge of streams or springs. Athens, OU; Belmont; Clark; Coshocton; Fairfield; Greene, C; Highland, OU; Hocking; Jackson, OU; Lake; Licking; Meigs, OU; Monroe; Morgan, OU; Ottawa, SL; Pickaway; Portage; Ross, OU; Shelby; Trumbull; Washington, M.

Bracythecium rutabulum (Hedw.) Bry. Eur. On soil, humus, rocks in a variety of situations. Ashtabula, C; Athens, OU; Belmont; Champaign; Clark; Coshocton; Cuyahoga; Fairfield;

Hardin; Highland, OU; Hocking; Jackson, OU; Lorain, Ob; Lucas; Mahoning; Mercer; Monroe; Morgan, OU; Ottawa, C; Pickaway; Portage; Ross; Shelby; Stark; Trumbull; Wood, BG.

Bracythecium salebrosum (Web & Mohr.) Bry. Eur. Base of trees, rotten logs, soil, humus and rocks in a variety of situations. Ashland; Athens, OU; Auglaize; Belmont; Columbiana; Cuyahoga, BW; Defiance; Fulton; Hardin; Highland, OU; Holmes; Lorain, Ob; Monroe; Ottawa, SL; Portage; Ross; Scioto; Stark; Summit; Tuscarawas; Van Wert; Washington, M; Wayne, C; Wood.

Bracythecium starkei (Brid.) Bry. Eur. Decaying logs. Athens, OU. Specimen at Carnegie Museum from Greene County det. by Sterki, unable to confirm or deny.

Brotherella delicatula (James) Fleisch. On rotten wood. Ashtabula; Lake.

Brotherella recurvans (MX) Fleisch. On rotten wood, humus, soil, rocks in moist, shaded areas. Ashland; Ashtabula; Athens, OU; Belmont; Coshocton; Cuyahoga; Hocking; Jackson, OU; Ross, OU; Trumbull; Washington, M.

Brotherella tenuirostris (Schimp.) Broth. On rotten logs or tree bases. Ashtabula; Champaign; Clark; Hocking; Jackson; Lake.

Bryhnia graminicolor (Brid.) Grout. On moist rock ledges, occasionally on soil in shaded areas. Adams; Ashtabula, C; Athens, OU; Auglaize; Clermont, UC; Coshocton; Franklin; Highland; Hocking; Jackson, OU; Lorain, Ob; Ottawa, SL, C; Ross, OU; Shelby; Van Wert; Wood, BG.

Bryhnia novae-angliae (Sull. & Lesq.) Grout. On rocks and soil near wet places, frequently on sandstone in southern Ohio. Ashtabula; Athens; Columbiana; Fairfield; Hocking; Jackson C; Lake; Monroe; Ottawa, SL; Richland; Ross, OU; Trumbull.

Calliergonella cuspidata (Brid.) Loeske. On soil in wet shaded areas. Athens, OU; Ross, OU. Reported from Cuyahoga by Claassen, not seen.

Calliergonella schreberi (Bry. Eur.) Grout. On soil in shaded areas, dry or moist situations. Adams, UC; Athens, OU; Champaign; Cuyahoga; Delaware; Highland, OU; Hocking; Jackson, OU; Lake; Lorain, Ob; Portage; Richland; Ross, OU; Trumbull.

Calliergon cordifolium (Hedw.) Kind. In bogs. Jackson, OU; Lake; Richland; Sandusky, C.

Calliergon trifarium (Web & Mohr.) Kindb. Reported by Lesquereux, Sullivant and Beardslee—the only specimen is in Ohio State University herbarium, a fossil from a peat bog.

Campylium chrysophyllum (Brid.) Bryhn. On soil, stones or humus in a wide variety of situations. Adams, UC; Athens, OU; Belmont; Clark; Darke; Defiance; Delaware, OW; Franklin; Geauga; Guernsey; Highland, OU; Hocking; Jackson, OU; Lake; Lorain, Ob; Monroe; Ottawa, SL; Pickaway, OU; Richland; Ross; Scioto; Shelby; Tuscarawas, C; Van Wert; Williams; Wood, BG.

Campylium hispidulum (Brid.) Mitt. Commonly on rotten logs, also on soil and humus at and on base of trees. Adams; Ashland; Ashtabula; Athens, OU; Clark; Coshocton; Fairfield; Franklin; Fulton; Greene; Hocking; Jackson; Lake; Logan; Montgomery; Morgan, OU; Ottawa, SL; Ross; Scioto; Shelby; Washington, M; Wood, BG. Reported by Claassen from Cuyahoga and Portage Counties, not seen.

Campylium polygamum (Bry. Eur.) Bryhn. Wet grassy areas. Erie, SL; Ottawa, SL.

Campylium radicale (Beauv.) Grout. In swamps on soil. Hardin; Lake; Lawrence; Ottawa, SL; Richland; Scioto; Washington, M; Williams.

Campylium stellatum (Hedw.) Lange and C. Jens. In swamps and bogs. Champaign; Erie, SL; Highland; Lorain, Ob; Ottawa, SL, C; Ross, OU; Stark, C.

Chamberlainia acuminata Hedw. Grout. On soil, decaying wood, occasionally on rocks in shaded areas. Allen, BW; Ashtabula, C; Clark; Coshocton; Cuyahoga; Delaware, OW; Franklin, BW; Hamilton, UC; Hocking; Lorain, Ob; Madison; Monroe, BW; Morrow; Ottawa, SL, C; Perry; Pickaway; Summit, C; Trumbull; Van Wert; Wood, BG.

Chamberlainia cyrtophylla (Kindb.) Grout. Roots of trees and old logs. Franklin; Greene, C; Ottawa, SL; Trumbull.

Cirriphyllum boscii (Schwaegr.) Grout. On soil, rock, humus in a variety of moisture and light conditions. Adams, UC; Ashtabula; Athens, OU; Champaign; Clark; Coshocton; Cuyahoga; BW, C; Fairfield; Franklin; Gallia; Geauga; Hamilton, UC; Highland, UC; Hocking; Jackson, OU, C; Lake; Lawrence, Ob; Meigs; Monroe, BW; Morgan, OU; Muskingum; Ottawa, SL, C; Richland; Scioto; Tuscarawas, C; Washington, M.

Cirriphyllum piliferum (Hedw.) Grout. This one specimen was collected in 1877 in Cedar Swamp. No further data. Champaign. Reported from Cuyahoga by Claassen; Lake County by Beardslee; specimens not seen.

Climacium americanum Brid. On soil or humus or rotting logs in shaded woods. Adams, UC; Athens, OU; Auglaize; Belmont; Brown; Champaign; Clark, C; Clermont, UC; Clinton; Coshocton; Crawford; Cuyahoga; Delaware, OW; Franklin; Geauga; Guernsey; Hancock; Highland; Hocking; Jackson, OU; Lake; Lorain, Ob; Lucas; Meigs, OU; Monroe; Montgomery; Morgan; Ottawa, SL; Portage; Richland; Ross, OU; Scioto; Seneca; Shelby; Summit; Trumbull; Tuscarawas, C; Van Wert; Vinton; Warren, UC; Washington, M; Wayne; Williams; Wood, BG.

Climacium dendroides (Hedw.) Web & Mohr. Wet ground, along stream banks in shaded areas. Adams, UC.

Climacium kindbergii (Ren. & Card.) Grout. In wet situations, cliff tops, rotton logs, humus, stream banks. Adams, UC; Ashtabula, C; Brown, UC; Clermont, UC; Crawford; Delaware; Franklin; Gallia; Henry; Hocking; Jackson, OU; Lake; Licking; Lorain, Ob; Morrow; Richland; Ross; Scioto; Shelby; Stark; Summit, C; Trumbull; Tuscarawas, C; Williams.

Cratoneuron commutatum (Hedw.) Roth. On wet limestone. Ross.

Cratoneuron filicinum (Hedw.) Roth. In swamps and bogs. Champaign; Greene, C; Highland; Jackson, OU; Lake; Pickaway, OU; Ross, OU; Wyandot.

Drepanocladus aduncus (Hedw.) Warnst. Wet places, especially bogs and swamps. Clark; Delaware, OW; Erie, SL; Franklin; Jackson; Lake; Logan; Lucas; Ottawa, SL; Pickaway; Ross, OU; Sandusky, C; Shelby; Union; Wood, BG.

Drepanocladus exannulatus (Gumb.) Warnst. In swamps or flowing streams. Adams; Jackson; Meigs.

Drepanocladus fluitans (Hedw.) Warnst. In very wet situations, floating or on rocks. Delaware, OW; Lake.

Drepanocladus revolvens (C. Mull) Warnst. In alkaline bogs. Champaign; Delaware, OW; Lorain, Ob; Ross, Stark.

Entodon brevisetus (Hook. & Wils.) Jaeger & Sauerb. On base of trees, limestone rocks and soil. Champaign; Clark; Delaware, OW. Reported from Cuyahoga County by Claassen, not seen.

Entodon cladorrhizans (Hedw.) C. Mull. Commonly on fallen trees, occasionally on soil, in shaded areas. Adams, UC; Ashtabula; Athens, OU; Belmont; Clark; Coshocton; Cuyahoga, C; Delaware, OW; Erie; Franklin, BW; Guernsey; Hocking, OU; Jackson; Lake; Lorain, Ob; Medina; Morrow; Ottawa, SL; Pickaway, OU; Portage; Richland; Ross; Shelby; Summit, C; Tuscarawas, C; Union; Washington, M; Wood, BG.

Entodon compressus (Hedw.) C. Mull. On soil and rotting logs in shade. Ashtabula, C; Cuyahoga, BW; Guernsey, C. Reported from Franklin County by Lesquereux, not seen.

Entodon seductrix (Hedw.) C. Mull. On decaying wood, tree bases, moist soil and stones, often in dry situations. Adams; Athens, OU; Auglaize; Belmont; Butler; Champaign; Clark, C; Coshocton; Cuyahoga; Delaware, OW; Erie; Fairfield; Fayette, OU; Franklin, BW; Greene; Hamilton, UC, BW; Hardin; Henry; Hocking, OU; Jackson, OU, C; Lake; Licking; Logan; Lorain, Ob; Madison; Meigs; Morrow; Pickaway, OU; Portage; Richland; Ross, OU; Scioto; Shelby; Summit, C; Trumbull; Van Wert; Vinton, OU; Washington, BW, M; Wayne, Ob; Wood.

Eurhynchium hians (Hedw.) Jaeger & Sauerb. On soil, wood and rocks in shaded areas. Athens, OU; Champaign; Coshocton; Cuyahoga; Erie, Ob; Fairfield; Franklin; Highland; Hocking; Jackson, OU; Lake; Miami; Monroe; Ottawa, SL; Paulding; Perry; Pickaway; Ross, OU; Shelby; Summit, C; Trumbull; Tuscarawas, C; Williams; Wood, BG.

Eurhynchium rusciforme (Neck.) Milde. In streams, on dripping rocks or other continuously moist areas. Cuyahoga, BW; Hocking; Jackson, OU; Monroe; Ottawa, SL; Portage; Washington, M. Reported from Summit and Geauga Counties by Claassen, not seen.

Eurhynchium serrulatum (Hedw.) Kindb. On rocks, tree bases, frequently on soil in forested regions. Ashtabula; Athens; Clark; Clermont, UC; Columbiana; Coshocton; Cuyahoga; Darke; Delaware, OW; Fairfield; Franklin, BW; Hocking; Jackson, OU; Lake; Licking;

Lorain, Ob; Meigs; Miami; Monroe; Ottawa, SL; Pickaway, OU; Pike; Portage; Richland; Ross, OU; Scioto; Summit; Trumbull; Union; Vinton; Washington, BW, M; Wayne, M; Wood, BG; Wyandot.

Eurhynchium strigosum (Hoffm.) Bry. Eur. On soil or tree bases. Athens, OU; Cuyahoga, BW; Delaware, OW; Fairfield; Geauga; Hamilton; Jackson, OU; Lake; Lorain, Ob; Paulding; Pickaway; Ross, OU; Union; Van Wert.

Heterophyllium haldanianum (Grev.) Kind. In woods on humus and rotting wood. Ashland; Ashtabula, C; Athens, OU; Coshocton; Cuyahoga, BW; Delaware, OW; Fairfield, UC; Hocking; Jackson, OU; Lake, Ob; Lorain, Ob; Morrow; Perry; Stark; Summit, C; Trumbull; Tuscarawas, C; Wood, BG.

Homalotheciella fabrofolia (Grout) Broth. On tree bark. Miami; Pickaway.

Homalotheciella subcapillata (Hedw.) Card. On bark of trees and decaying wood. Belmont; Champaign; Clark; Greene; Highland; Jackson; Pickaway; Ross; Scioto; Van Wert. Reported from Cuyahoga County by Claassen; specimen not seen.

Homomallium adnatum (Hedw.) Broth. On moist rocks, rotten wood and bark. Ashtabula; Belmont; Champaign; Delaware, OW; Franklin, S, OU; Highland; Hocking; Jackson, OU; Ottawa, C; Paulding; Pickaway; Portage; Richland; Ross, OU; Scioto; Shelby; Washington, M; Wood, BG; Wyandot. Reported from Cuyahoga and Lake Counties; not seen. Recently reported from Athens County by Robinson.

Hygroamblystegium fluviatile (Hedw.) Loeske. In springs, wet dripping cliffs and streams. Athens; Coshocton; Cuyahoga; Erie, SL; Greene; Highland, OU; Hocking; Jackson; Monroe; Ottawa, SL, C; Washington, M.

Hygroamblystegium irriguum (Wils.) Loeske. On rocks in streams or on soil at edge of streams. Adams; Ashland; Athens, OU; Belmont; Carroll; Champaign; Clark; Coshocton; Delaware, OW; Erie, SL, C; Fairfield; Franklin; Geauga; Greene, C; Hamilton, UC; Hocking; Huron, Ob; Jackson; Lake; Logan; Lorain; Monroe; Ottawa, SL, C; Pickaway; Richland; Ross; Shelby; Trumbull; Union; Washington, M.

Hygroamblystegium orthocladon (Beauv.) Grout. In running water on stones or soil. Adams; Athens, OU; Belmont; Clark; Coshocton; Delaware; Fairfield, BW; Franklin; Highland, OU; Hocking; Jackson; Logan; Monroe; Ottawa; Pickaway; Richland; Ross; Shelby; Trumbull; Union; Vinton.

Hygrohypnum closteri (Aust.) Grout. On rocks in streams. Belmont.

Hygrohypnum eugyrium (Bry. Eur.) Loeske. On rocks in streams. Geauga; Ottawa, SL.

Hygrohypnum palustre (Hedw.) Loeske. On rocks in streams. Adams; Erie; Ottawa, C, SL.

Hylocomnium brevirostre (Beauv.) Bry. Eur. Shady creek banks on stones and soil. Ashland; Athens, OU; Belmont; Hocking; Jackson, OU; Lake; Monroe. Reported from Cuyahoga County by Claassen; no specimen.

Hylocomnium splendens (Hedw.) Bry. Eur. On humus, decaying wood and rocks along stream banks. Cuyahoga.

Hypnum crista castrensis Hedw. On humus in woods. Adams; Jackson, OU; Pike. Reported from Cuyahoga and Summit Counties by Claassen; no specimen.

Hypnum cupressiforme Hedw. On soil. Lake, Ob; Lorain, Ob. Reported from Cuyahoga and Summit Counties by Claassen; no specimen.

Hypnum curvifolium Hedw. On soil, rocks, rotting logs. Adams, UC; Ashland; Athens, OU; Clark; Clinton; Coshocton; Cuyahoga; Fairfield; Franklin, BW; Guernsey; Hamilton, UC; Highland, OU; Hocking; Jackson, OU, C; Lake; Lawrence; Licking; Lorain, Ob; Lucas; Meigs; Monroe; Morrow; Ottawa, SL; Pickaway, OU; Ross, OU; Scioto, OU; Seneca; Shelby; Stark; Trumbull; Tuscarawas, C; Washington, M; Williams.

Hypnum fertile Sendt. On decaying wood. Athens, OU; Jackson, OU.

Hypnum imponens Hedw. On rotting wood in shaded areas. Adams, UC; Ashtabula; Athens, OU; Auglaize; Belmont; Carroll; Coshocton; Delaware, OW; Fairfield; Franklin; Greene; Hocking; Jackson, OU; Lake; Licking; Lorain, Ob; Meigs, OU; Monroe; Richland; Ross; Scioto; Trumbull; Vinton; Washington, M; Wayne, C; Wood, BG. Reported from Cuyahoga, Portage and Summit Counties by Claassen; not seen.

Hypnum molluscum Hedw. On rocks and soil in shaded areas. Adams, UC; Ashtabula, C;

Athens, OU; Champaign; Coshocton; Fairfield; Geauga; Hocking; Jackson, OU; Lake; Monroe; Richland; Ross; Scioto; Tuscarawas, C; Vinton. Reported by Claassen from Cuyahoga County; not seen.

Hypnum patientiae Lindb. On rocks, soil, rotten wood in very moist situations. Adams; Ashtabula, C; Athens, OU; Carroll; Champaign; Coshocton; Cuyahoga, C; Fairfield, OU; Franklin; Greene, OU; Guernsey; Highland, OU; Hocking; Jackson, C; Lake, Ob; Licking; Logan; Monroe; Morrow; Pickaway; Portage; Richland; Ross, OU; Shelby; Stark; Tuscarawas, C; Wayne; Wood, BG.

Hypnum pratense Koch. Wet places in open swamps and meadows. Clark; Summit; Wood, BG. Reported from Cuyahoga and Licking Counties by Claassen; not seen.

Hypnum reptile MX. On rotting logs, rocks and soil. Ashtabula, C; Clark; Columbiana; Hocking; Portage; Trumbull.

Leptodictyum riparium (Hedw.) Warnst. On stocks, logs, roots of trees and rocks in swamps or streams. Adams; Athens, OU; Auglaize; Clark; Erie, SL; Franklin, BW; Geauga; Hardin; Highland; Jackson, OU; Lake; Lawrence; Licking; Lorain, Ob; Mahoning; Morrow; Ottawa, SL; Pickaway, OU; Portage; Richland; Ross, OU; Scioto; Shelby; Trumbull; Washington, M; Wood, BG. Forma *fluitans* reported from Cuyahoga County by Claassen; not seen.

Leptodictyum trichopodium (Schultz) Warnst. On rotten logs, stones and soil in swamps or slow moving streams. Athens, OU; Champaign; Coshocton; Erie, SL; Franklin; Hardin; Highland; Jackson; Lake; Madison; Miami; Muskingum; Ottawa, SL; Pickaway, OU; Richland; Scioto; Shelby; Trumbull; Wood, BG.

Plagiothecium denticulatum (Hedw.) Bry. Eur. On rocks, soil in shady wooded areas. Ashland; Ashtabula, C; Athens, OU; Auglaize; Belmont; Coshocton; Cuyahoga, C; Delaware, OW; Fairfield; Franklin; Hancock; Hardin; Hocking, C; Jackson, OU; Lake; Licking; Lorain, Ob; Monroe; Ottawa, SL; Pickaway; Pike; Portage; Richland; Ross, OU; Summit, C; Trumbull; Tuscarawas; Washington, M; Williams; Wood, BG.

Plagiothecium deplanatum (Sull.) Grout. On shaded, moist rocks, occasionally on soil. Adams; Athens, OU; Belmont; Clark; Highland; Monroe; Ottawa, SL; Perry; Pickaway, OU; Ross; Scioto.

Plagiothecium elegans (Hook.) Sull. On soil, rotten logs and sandstone in shaded areas. Ashtabula; Belmont; Hocking; Jackson, OU; Monroe; Portage.

Plagiothecium geophillum (Aust.) Grout. On moist shaded sandstone. Belmont; Clark; Coshocton; Fairfield; Franklin; Mahoning, C; Montgomery, C; Ottawa, SL; Pickaway; Ross, OU; Scioto; Wood, BG. Reported recently from Athens County by Robinson.

Plagiothecium laetum Bry. Eur. Mostly on moist sandstone, occasionally on tree bases. Champaign; Fairfield; Jackson; Portage; Scioto; Trumbull.

Plagiothecium latebricola (Wils.) Bry. Eur. On rotten wood and moist sandstone. Jackson.

Plagiothecium muellerianum Schimp. On conglomerate cliff faces in the shade. Belmont; Delaware, OW; Erie, Ob; Hocking; Portage. Reported recently from Athens County by Robinson.

Plagiothecium pulchellum (Hedw.) Bry. Eur. On moist stones in shaded areas. Ottawa, SL.

Plagiothecium roseanum (Hampe) Bry. Eur. On soil and moist sandstone in cool, shady areas. Ashtabula; Athens, OU; Belmont; Clark; Hocking; Lorain, Ob; Monroe; Pickaway, OU; Portage; Richland. Reported from Cuyahoga, Lake and Summit Counties by Claassen; specimen not seen.

Plagiothecium ruthei Limpr. In swamps. Ross.

Plagiothecium striatellum (Brid.) Lindb. Vertical faces of moist sandstone cliffs. Champaign; Jackson, OU; Pike; Portage; Trumbull.

Plagiothecium sylvaticum (Brid.) Bry. Eur. On moist rocks, tree roots, rotten logs in very moist situations. Ashtabula, C; Athens, OU; Belmont; Cuyahoga; Franklin; Hocking; Jackson, C; Ottawa, SL; Stark; Tuscarawas, C; Wood, BG.

Plagiothecium turfaceum (Lindb.) Lindb. On soil and rock in shaded moist areas. Cuyahoga; Jackson; Lorain, Ob; Paulding; Portage.

Platygerium repens (Brid.) Bry. Eur. On bark of trees in a variety of light conditions. Ashland; Ashtabula; Athens, OU; Auglaize; Belmont; Champaign; Clark; Clermont, UC; Coshocton, C; Cuyahoga; Darke; Delaware, OW; Fairfield; Franklin, BW; Greene, C; Guernsey;

Hamilton, UC; Hardin; Highland; Hocking; Jackson, OU; Lake; Licking; Lorain, Ob; Mercer; Miami; Morrow; Noble; Paulding; Perry; Portage; Richland; Ross, OU; Scioto; Shelby; Summit; Trumbull; Tuscarawas, C; Union; Van Wert; Washington, M; Wayne; Williams; Wood, BG.

Porotrichum alleghenience (C. Mull.) Grout. Near waterfalls, streams or other continuously moist areas. Athens, OU; Belmont; Fairfield; Gallia; Greene; Hocking; Jackson, OU; Lake; Meigs, OU; Monroe; Ross; Washington.

Pylasia intricata (Hedw.) Bry. Eur. On bark of living trees. Ashtabula; Highland, OU; Lorain, Ob; Monroe. Reported from Cuyahoga, Lake, Erie and Perry Counties by Claassen; specimen not seen.

Pylasia selwynii Kindb. On bark of living trees. Adams; Athens, OU; Belmont; Clark; Franklin; Highland; Hocking; Lake; Lorain, OB; Miami; Pickaway, OU; Richland; Ross, OU; Scioto. Reported by Claassen from Cuyahoga, Geauga, Lake and Summit Counties; not seen.

Pylasia subdenticulata Schimp. On bark of living trees. Clark. Reported by Sullivant from Franklin County; not seen.

Rhytidiadelphus triquetrus (Hedw.) Warnst. Moist humus of forest floor. Champaign; Cuyahoga; Fairfield; Jackson; Lake; Pickaway, OU.

Rhytidium rugosum (Hedw.) Kind. Top of exposed cliffs in fairly dry situations. Adams, UC; Athens; Clark; Fairfield; Greene; Lorain, Ob; Monroe, BW; Pike; Ross; Vinton. Reported from Cuyahoga and Summit Counties by Claassen; not seen.

Sciaromium lescurii (Sull.) Broth. On rocks in streams, waterfalls. Fairfield; Hocking; Jackson.

Scorpidium scorpioides (Hedw.) Limpr. In bogs, found only in cedar swamp. Champaign, Ob.

Sematophyllum adnatum (MX.) E. G. Britton. Usually on rotting logs, occasionally on tree bases. Champaign; Coshocton; Cuyahoga; Delaware, OW; Highland; Hocking.

Sematophyllum carolinianum (C. Mull.) E. G. Britton. On sandstone cliff tops, tree bases, occasionally on rocks in streams. Ashland; Ashtabula; Athens, OU; Coshocton; Fairfield; Hocking; Jackson, OU; Lawrence; Lorain, Ob; Portage; Richland; Scioto; Summit; Vinton. Reported from Cuyahoga County by Claassen; not seen.

Sematophyllum marylandicum (C. Mull.) E. G. Britton. On moist rocks near streams. Hocking.

Leskeaceae

Anomodon attenuatus (Hedw.) Huben. On shaded rocks and tree bases. Adams, UC; Ashland; Ashtabula, C; Athens, OU; Auglaize; Belmont; Butler; Champaign; Clark, C; Clermont, UC; Coshocton; Cuyahoga; Delaware, OW; Erie; Fairfield; Franklin; Hamilton, UC; Hancock; Highland, OU; Hocking, OU; Holmes, OU; Jackson, OU, C; Lake; Licking; Lorain, Ob; Madison; Medina; Meigs; Miami; Monroe; Morgan, OU; Morrow; Ottawa, SL; Paulding; Pickaway; Portage; Richland; Scioto; Seneca; Trumbull; Tuscarawas, C; Union; Van Wert; Washington, BW, M; Wayne; Williams; Wood, BG.

Anomodon minor (Beauv.) Lindb. On tree trunks, limestone bluffs, occasionally on soil. Adams; Ashtabula, C; Athens, OU; Belmont; Clark; Cuyahoga; Delaware, OW; Fairfield; Franklin; Greene; Hamilton, UC; Highland, OU; Hocking; Jackson, OU; Lake; Meigs; Ottawa, SL; Richland; Ross; Sandusky; Scioto; Shelby; Trumbull; Van Wert; Wood, BG.

Anomodon rostratus (Hedw.) Schimp. Base of trees, rock ledges, soil in forested areas. Adams; Athens, OU; Auglaize; Belmont; Clark, C; Clermont, UC; Coshocton; Cuyahoga; Delaware, OW; Erie, SL; Fairfield; Franklin; Gallia; Greene; Guernsey; Hamilton, UC; Highland, OU; Hocking; Jackson, OU; Lake; Licking; Logan; Lorain, Ob; Lucas; Meigs; Miami; Monroe; Ottawa, SL, C; Paulding; Portage; Richland; Ross; Scioto; Seneca; Shelby; Summit; Tuscarawas, C; Union; Van Wert; Vinton; Washington, M; Williams; Wood, BG.

Anomodon rugelii (C. Mull.) Keissl. Base of trees in moist woods. Lake; Ottawa, SL.

Haplohymenium triste (Cesati) Kindb. On bark of living trees. Adams; Athens, OU; Champaign; Coshocton; Delaware, OW; Highland, OU; Hocking; Jackson, OU; Lake; Miami; Monroe; Ross; Scioto.

Helodium blandowii (Web. & Mohr.) Warnst. In moist swampy areas on soil. Lorain, Ob; Summit, C; Trumbull. Reported from Geauga, Lake and Portage Counties by Claassen; specimen not seen.

Helodium paludosum (Sull.) Aust. Base of trees or soil in swampy areas. Clermont, UC; Cuyahoga, C; Defiance; Geauga; Hocking; Jackson; Lorain, Ob; Ross; Scioto; Trumbull; Vinton.

Leskea arenicola Best. Base of living trees. Delaware; Jackson; Ross.

Leskea gracilescens Hedw. On living trees, especially near the base, occasionally on soil. Adams; Athens, OU; Clark; Delaware; Fairfield; Franklin, OU; Highland, OU; Hocking; Jackson, OU; Licking; Lucas; Madison; Pickaway, OU; Richland; Ross, OU; Sandusky; Union; Van Wert; Washington, M; Williams; Wood, BG.

Leskea nervosa (Schwaegr.) Mylin. Base of trees. Ottawa, SL.

Leskea obscura Hedw. On bark of living trees, especially near the base. Athens, OU; Champaign; Clark, C; Cuyahoga; Defiance; Delaware; Fairfield; Franklin; Hamilton, UC; Highland; Hocking; Lake; Licking; Lorain, Ob; Madison; Morgan, OU; Paulding; Pickaway; Ross, OU; Scioto; Shelby; Trumbull; Union; Van Wert; Wood, BG; Wyandot.

Leskea polycarpa Hedw. On logs, trees, rocks in moist places. Adams; Ashtabula; Athens, OU; Cuyahoga; Franklin; Geauga; Jackson; Montgomery; Morgan; Pickaway, OU; Pike; Ross, OU; Trumbull; Union; Washington, M; Wood, BG.

Lindbergia brachyptera (Mitt.) Kindb. Bark of living tree. Franklin; Greene; Hardin; Morrow; Ross; Sandusky; Union.

Myurella careyana Sull. On shaded limestone rocks. Adams; Cuyahoga; Greene.

Thelia asperella Sull. Base of trees, logs, sandstone. Adams, UC; Athens, OU; Clark; Cuyahoga; Delaware, OW; Erie; Highland; Hocking; Jackson, OU; Lorain, Ob; Montgomery; Ottawa; Perry; Pike; Ross, OU; Scioto; Vinton, OU.

Thelia hirtella (Hedw.) Sull. Base of living trees, occasionally on rocks. Adams, UC; Athens, OU; Champaign; Clark; Clermont, UC; Cuyahoga; Delaware, OW; Erie, Ob; Franklin; Greene; Hocking; Jackson; Lake; Lorain, Ob; Lucas; Meigs; Monroe; Pike; Richland; Ross, OU; Scioto. Includes *T. lescurii* Sull. (1 specimen, Lucas County).

Thuidium delicatulum (Hedw.) Mitt. On soil, rotten wood and stones in moist shaded places. Adams, UC; Ashtabula; Athens, OU; Auglaize; Belmont; Champaign; Clermont, UC; Coshocton; Cuyahoga, BW; Defiance; Delaware, OW; Erie, Ob; Franklin; Gallia; Guernsey; Highland, OU; Hocking; Holmes, OU; Jackson, OU; Lake; Licking; Lorain, Ob; Monroe; Morgan; Portage; Richland; Ross; Scioto; Stark; Summit, C; Trumbull; Vinton; Warren, UC; Washington, M; Wayne, C; Williams; Wood, BG; Wyandot.

Thuidium microphyllum (Hedw.) Best. On rotten logs and tree roots. Clark; Franklin; Geauga; Jackson; Morrow; Pickaway, OU; Richland; Ross; Wood. Reported from Cuyahoga County by Claassen; not seen. Reported recently from Athens County by Robinson.

Thuidium minutulum (Hedw.) Bry. Eur. On rotten wood. Clark; Jackson, OU; Lorain, Ob; Pickaway; Wood, BG. Reported by Claassen from Cuyahoga County; not seen.

Thuidium pygmaeum Bry. Eur. On limestone or sandstone. Adams; Athens, OU; Ross, OU; Scioto. Reported from Cuyahoga County by Claassen; not seen.

Thuidium recognitum (Hedw.) Lindb. On rocks and soil in moist areas. Adams; Athens; Champaign; Clinton; Cuyahoga; Franklin; Jackson; Lake; Lawrence; Logan; Morgan; Portage; Ross, OU; Summit; Tuscarawas, C; Washington, M.

Thuidium scitum (Beauv.) Aust. Bark of living trees. Clark; Hocking; Jackson; Lake; Lorain, Ob. Reported from Cuyahoga County by Claassen; not seen.

Thuidium virginianum (Brid.) Lindb. On rocks and soil in shaded, wooded areas. Adams, UC; Athens; Hocking; Jackson, OU; Lawrence; Noble; Pickaway, OU; Ross, OU; Scioto; Wood, BG. Reported by Claassen from Cuyahoga County; not seen.

Hookeriaceae

Hookeria acutifolia Hook. On surface of cold sandstone cliffs and overhangs. Athens, OU; Fairfield; Hocking; Jackson, OU; Licking.

Neckeraceae

Neckera pennata Hedw. On bark of living trees in wooded areas. Champaign; Cuyahoga; Hocking; Jackson, OU; Lake.

Leucodontaceae

Leptodon ohioensis Sull. Bark of living trees in deep woods. Franklin, BW. Reported by Sullivant from Greene County; not seen.

Leptodon trichomitrion (Hedw.) Mohr. Bark of living trees, particularly in shaded areas in valleys of southern Ohio. Adams, UC; Athens, OU; Champaign; Clark; Franklin; Greene; Highland, OU; Hocking, OU; Jackson, OU; Lake; Monroe; Morgan; Perry; Ross; Vinton, OU. Reported by Beardslee as from Cincinnati, Ohio; not seen.

Leucodon brachypus Brid. Bark of living trees. Lake.

Leucodon julaceus (Hedw.) Sull. Bark of living trees in wooded areas. Adams; Auglaize, BW; Belmont; Champaign; Clark; Cuyahoga; Delaware; Erie; Fairfield, Ob; Franklin, BW; Greene; Guernsey; Highland, OU; Jackson, OU, C; Lawrence; Miami; Montgomery; Ottawa; Pickaway, OU; Ross, OU; Scioto; Vinton.

Leucodon sciuroides (Hedw.) Schwaegr. On bark of trees and rotting logs in shaded areas. Athens, OU; Franklin; Greene; Highland; Miami; Pickaway; Pike, OU.

Crypaeaceae

Cryphaea glomerata Schimp. Bark of living trees. Franklin, SL; Hamilton, SL; Highland, OU; Scioto.

Fabroniaceae

Anacamptodon splachnoides (Froehl.) Brid. On roots of trees or in knot holes, particularly beech trees. Clark; Highland, OU; Lorain, Ob; Richland; Ross, OU. Reported from Cuyahoga County by Claassen; not seen.

Clasmatodon parvulus (Hampe) Sull. Bark of living trees, usually in open areas. Highland, OU; Hocking; Jackson; Ross; Scioto; Shelby.

Fabronia ciliaris (Brid.) Brid. Bark of living trees, usually in open areas. Jackson; Pickaway, OU; Ross.

Fabronia ravenelli Sull. Bark of living trees. Ross.

Schwetschkeopsis denticulata (Sull.) Broth. On tree bark and rocks in shaded areas. Adams; Athens, OU; Clark; Highland; Hocking, OU; Scioto.

Fontinalaceae

Dichelyma capillaceum Bry. Eur. In streams, ponds, swamps. Jackson, OU; Ross, OU.

Fontinalis biformis Sull. On rocks in swift flowing streams. Adams; Franklin, SL; Highland; Portage, C.

Fontinalis dalecarlica Bry. Eur. In swift flowing streams. Adams; Hocking; Lorain, Ob; Trumbull.

Fontinalis disticha Hook. & Wils. In swift flowing streams. Athens, OU; Wood, BG.

Fontinalis lescurii Sull. In swift flowing streams. Jackson, OU.

Fontinalis missourica Card. In swift flowing streams. Franklin.

Fontinalis novae-angliae Sull. In swift flowing streams. Adams; Ashtabula; Athens, OU; Brown; Hocking; Jackson, OU; Portage; Vinton, OU.

Sphagnaceae

Sphagnum capillaceum (Weiss.) Schrank. Ashtabula; Athens; Champaign; Franklin; Hocking; Jackson; Lake; Licking; Stark.

Sphagnum compactum D.C. Hocking; Jackson; Portage.

Sphagnum fimbriatum Wils. Athens.

Sphagnum fuscum (Schimp.) H. Klinggr. Licking.

Sphagnum imbricatum Hornsch. Jackson.

Sphagnum magellanicum Huron; Licking; Richland; Scioto; Williams.

Sphagnum palustre Ashtabula; Champaign; Hocking; Huron; Jackson; Licking; Stark; Williams.

Sphagnum plumulosum Roll. Franklin; Jackson; Licking.

Sphagnum recurvum Beauv. Licking; Williams. Reported recently from Vinton County by Robinson.

Sphagnum squarrosum Crome. Summit.
Sphagnum subsecundum Nees. Jackson; Williams. Reported recently from Vinton County by Robinson.
Sphagnum tenellum Pers. Delaware.
Sphagnum teres (Schimp.) Angstr. Franklin.
Sphagnum warnstofii Russow. Champaign; Lake.
Sphagnum wulfianum Girg. Coshocton.

Doubtful Specimens from Ohio

Acoulon triquetrum (Spruce) C. Mull. Reported by Jennings from Ohio. No specimen seen.
Barbula convoluta (Huds.) Hedw. Reported by Beardslee. Wareham records a specimen from the Farlow herbarium. This author has not seen a specimen.
Bracythecium flagellare (Hedw.) Jennings. Packets in the Ohio University herbarium from Athens, Jackson and Meigs Counties which this author is unable to determine or confirm. One specimen reported from Washington County, Marietta College herbarium, not seen.
Bracythecium populeum (Hedw.) Br. and Sch. Reported from Cuyahoga County by Claassen, from Ohio by Beardslee and from Washington County by Conard. There is apaprently a specimen in H. S. Conard's collection, but not seen by the author.
Bracythecium velutinum (Hedw.) Bry. Eur. Reported from Cuyahoga County by Claassen. Packets from Wood County in Bowling Green herbarium and from Tuscarawas in Carnegie Museum, the author is not able to confirm these.
Bryum inclinatum (Sw.) Bry. Eur. Reported from Summit County by Claassen, not seen.
Bryum pallescens Schleich. Reported from Ohio by Sullivant and Beardslee. Specimen not seen.
Bryum uliginosum (Brid.) Bry. Eur. Reported by Sullivant and Beardslee. Packet in University of Cincinnati from Clermont County. Author not able to confirm.
Calliergon giganteum (Schimp.) Kind. Reported by Beardslee. Not seen.
Calliergon stramineum (Dick.) Kind. Reported by Beardslee. Not seen.
Camptothecium nitens (Schreb.) Schimp. Reported by Beardslee, not seen. The only specimen is a fossil from interglacial deposits.
Desmatodon plinthobius Sull. and Lesq. Reported by Beardslee, not seen.
Dicranella cerviculata (Hedw.) Schimp. Reported by Lesquereux and Beardslee, not seen.
Dicranum bergeri Bland. Reported by Beardslee, not seen.
Drepanocladus uncinatus (Hedw.) Warnst. No packets so labelled were confirmed.
Eurhynchium diversifolium (Schleich) Br. and Sch. Reported by Lesquereux, Sullivant and Beardslee. Specimens not seen.
Fissidens bryoides Hedw. Specimens from Wood County in Bowling Green herbarium; unable to confirm. Reported by Beardslee and a specimen is in Sullivant herbarium from Cincinnati, Ohio. Not seen by the author.
Fissidens grandifrons Brid. Reported by Mrs. E. G. Britton, not seen.
Fissidens hyalinus Hook. and Wils. Reported by Beardslee, Lea, Jennings and Sullivant. Not seen.
Fontinalis antipyretica (L) Hedw. Reported by Claassen, not seen.
Funaria americana (Lindb) Reported by Holzinger and Jennings, not seen.
Grimmia laevigata Brid. Reported by Sullivant and Beadslee, no specimen. Recently by Robinson from Athens County.
Habrodon purpusillus (Denot) Lindb. Reported by Sullivant. Grout's comment about this material was that it is the attenuate branches of *Leucodon julaceus*. Not seen.
Hygrohypnum ochraceum (Turn.) Loeske. Reported by Claassen from Cuyahoga County, not seen.
Meesia triquetra (L. Hook and Tayl.) Angstr. Reported from Ohio by Jennings and Beardslee. Not seen.
Meesia uliginosa Hedw. Reported by Beardslee. Not seen.
Mnium lycopodioides (Hook.) Schw. Reported by Beardslee. Not seen.
Mnium orthorhynchum Brid. In the Ohio University herbarium from Jackson County, unable to confirm.

Oncophorus virens (Ws) Brid. Reported by Beardslee, not seen.
Oncophorus wahlenbergii Brid. Reported by Grout from Ohio, not seen.
Orthotrichum cupulatum (Hoffm.) Brid. Reported by Beardslee, not seen.
Philonotis muhlenbergii (Schw.) Brid. Reported by Lesquereux, not seen.
Physcomitrium hookeri Hampe. Reported by Sullivant and Britton, not seen.
Pohlia atropurpurea (Wahlenb.) H. Lindb. Reported by Beardslee, specimen not seen.
Pohlia cruda (L.) Lindb. Reported by Beardslee, not seen.
Pohlia delicatula (Hedw.) Grout. Specimen at Ohio University, confirmed by Conard. Not enough remaining to examine.
Polytrichum formosum Hedw. Reported by Beardslee. Specimens at Ohio State University are *P. gracile.*
Seligeria recurvata (Hedw.) B & S. Reported by Sullivant (Musc. All.)
Seligeria trifaria (Brid.) Lindb. Reported by Sullivant and Holzinger; not seen.
Splachnum ampullaceum (L.) Hedw. Reported by Beardslee and Lesquereux, not seen.
Trematodon ambiguous (Hedw.) Horsnch. Reported by Beardslee, not seen.
Weisia microstoma (Hedw.) C. Muell. Distributed in Musc. Bor. Amer. #54, presumably from Ohio.

ACKNOWLEDGMENTS

The author expresses his gratitude to the many persons who have aided him by making specimens available, identifying doubtful specimens, collecting, and encouraging throughout the course of this study. The author is especially indebted to Dr. R. T. Wareham, Dr. G. W. Blaydes, Dr. A. J. Sharp, Dr. H. S. Conard, Dr. C. E. Taft, and Dr. Winona Welch.

REFERENCES

Beardslee, H. C., Sr. 1878. Catalogue of the plants of Ohio, including flowering plants, ferns, mosses and liverworts. 32nd Ann. Rept. Ohio State Board Agric. 1877: 335–363.
Braun, E. Lucy. 1928. Glacial and post-glacial plant migrations indicated by relic colonies of southern Ohio. Ecology 9: 284–302.
———. 1934. A history of Ohio's vegetation. Ohio Jour. Sci. 34: 247–257.
———. 1950. Deciduous Forests of Eastern North America. 596 pp. Philadelphia.
Brotherus, V. F. 1893–1909. Musci, In Engler and Prantl, Die Naturlichen Pflanzenfamilien 1(3): 1–1246. Leipzig.
Bruch, P., W. P. Schimper, and **Th. Gumbel.** 1836 1864. Bryologia Europaea. 6 vols. and suppl. Stuttgart.
Cassels, J. L. 1854. Mosses found in the vicinity of Cleveland, Ohio. Ann. Sci. 2: 3–4, 46–47, 102–103.
———. 1874. Mosses found in the vicinity of Cleveland. Proc. Cleveland Acad. Nat. Sci. 1845–1859: 65–74.
Claassen, E. 1895. List of cryptogamous plants of Cuyahoga County, Ohio. 3rd Ann. Rept. Ohio Acad. Sci.: 19–21.
———. 1896. List of mosses and Hepaticae, new or rare in Ohio. 4th Ann. Rept. Ohio Acad. Sci.: 33.
———. 1904. List of the mosses of Cuyahoga and other counties of northern Ohio. Ohio Nat. 4: 157–160.
———. 1919. Mosses of several Ohio counties. Ohio Jour. Sci. 19: 362–366.
Coles, C. H. 1933. The mosses of Franklin County with keys to the genera. Unpub. Masters Thesis. Ohio State University.
Emmitt, R. W. 1950. A contribution on the occurrence and distribution of bryophytes in Wood County, Ohio. Unpub. Masters Thesis. Bowling Green State University.
Fenneman, N. M. 1938. Physiography of Eastern United States. 714 pp. McGraw Hill, New York.
Grout, A. J. 1928–40. Moss Flora of North America north of Mexico. 3 vols. Newfane, Vermont.
Henderson, Nellie F. 1925. Ohio mosses, Polytrichales. Ohio Jour. Sci. 25: 177–182.
———. 1927. Ohio mosses, Bryales. Ohio Jour. Sci. 27: 1–18.
———. 1929. Ohio mosses, Dicranales. Ohio Jour. Sci. 29: 197–217.
———. 1930. A check list of Ohio mosses.Proc. Ohio Acad. Sci. 8 40th Ann. Meeting 393.
———. 1931. Ohio mosses, Hypnales. Ohio Jour. Sci. 31: 44–75.
Jennings, O. E. 1913. Manual of mosses of western Pennsylvania. 2nd ed. 1951. Amer. Mid. Natur. Monograph No. 6.

Kellerman, N. A. and **W. C. Werner.** 1893. Catalogue of Ohio plants. Rept. Geol. Survey Ohio 7(2): 56–406.
Lea, T. G. 1849. Catalogue of Plants, Native and Naturalized, Collected in the Vicinity of Cincinnati, Ohio, during 1834–44. Collins. Philadelphia.
Lesquereux, L. and **T. P. James.** 1884. Manual of Mosses of North America. 447 pp. Boston.
Morgan, A. P. 1878. A Flora of the Miami Valley. 68 pp. Dayton Literary Union.
Riddell, J. L. 1835. Synopsis of the Flora of the Western States. 116 pp. Cincinnati.
———. 1836. Supplementary catalogue of Ohio Plants. Western Jour. Med. and Phys. Sci. 9(36): 567–592.
Robinson, H. 1957. Moss collections from southeastern Ohio. Ohio Jour. Sci. 57(1): 15–20.
Rogers, A. D. 1940. "Noble Fellow." 361 pp. Putnam, New York.
Schnooberger, I. and **F. Wynne-Hillier.** 1954. Some interesting species of Bryophytes from Islands in Lake Erie. Papers Mich. Acad. Sci., Arts, and Letters. 39: 37–52.
Sears, P. B. 1930. A record of post-glacial climate in North America. Ohio Jour. Sci. 30: 205–217.
Sharp, A. J. 1939. Taxonomical and ecological studies of eastern Tennessee bryophytes. Amer. Midl. Nat. 21: 267–354.
Sullivant, W. S. 1856. Musci and Hepaticae of the United States. 112 pp. George P. Putnam & Co., New York.
———. 1864. Supplement 1874. Icones Muscorum. Cambridge.
———. 1843. Musci Alleghanienses. 2 vols.
——— and **L. Lesquereux.** 1865. Musci Boreali-Americani. Ed. 2. Columbus.
Tight, W. G. 1903. Drainage modifications in southeastern Ohio. U. S. Geol. Surv. Prof. Paper 13.
Transeau, E. N. 1941. Prehistoric factors in the development of the vegetation of Ohio. Ohio Jour. Sci. 41: 207–211.
———. 1935. The Prairie Peninsula. Ecology 16: 423–437.
Ver Steeg, K. 1946. The Teays River. Ohio Jour. Sci. 46: 297–307.
Walters, M. B. 1952. Mosses of a northern Ohio area. Ohio Jour. Sci. 52: 291–295.
Wareham, R. T. 1941a. The mosses of Neotoma, Hocking County, Ohio. Bryologist 44: 56–59.
———. 1941b. Recent moss collections from Ohio. Bryologist 44: 42–46.
Wolfe, J. N. 1940. Species isolation and a pro-glacial lake in southern Ohio. Ohio Jour. Sci. 40: 1–12.

Freshwater Fishery Biology. *Karl F. Lagler.* Wm. C. Brown Co., Dubuque, Iowa. Second edition. 1956. xii+421 pp. $6.75.

Professor Lagler's experience as a teacher is manifest throughout his textbook. It begins with statements of methods of observing and collecting fishes, follows with lessons in elementary ichthyology, *i.e.*, statements about the families of freshwater fishes with lists of keys to the fishes of each state and province, then tells students how to make bibliographies. Students are supplied with the basic facts about fish anatomy and embryology, growth rates, foods, diseases and parasites, and fish populations.

Several chapters cover subjects pertinent to fish management, including pollution, legal restrictions, culture, surveys, methods for improving waters for fish production, and the creation of new impoundments. Final chapters cover the commercial and sport fisheries, and a series of appendices give sample scales by families, survey forms, abbreviations, diseases, conversion tables, and check-list with economic classification of North American fresh-water fishes.

A useful book for teachers of fisheries biology in the United States and Canada, creditably unburdened with the emphasis on statistical methods which distinguishes its major competitor. Its index is useful but not complete. Its photographs are excellent illustrations of the ideas presented. Its main weakness is its author's lack of first hand experience with the Great Lakes and their fisheries, and of familiarity with pertinent literature about those waters.

THOMAS H. LANGLOIS

A NOTE ON THE BIOLOGY OF THE MOSQUITO, *PSOROPHORA DISCOLOR* (COQUILLETT), IN MISSISSIPPI

(DIPTERA: CULICIDAE)

LAFE R. EDMUNDS

Principal Entomologist, Sanitary Engineering Branch, Engineer Research and Development Laboratories, Fort Belvoir, Virginia

Psorophora discolor (Coquillett) is found from Mexico northward to New Jersey and westward to Oklahoma. It reaches peak populations in the rice growing areas of Mississippi, Arkansas, and Louisiana, where it is an important and serious pest of men and livestock. Mathis *et al.* (1955), in a previous study in Bolivar County, Mississippi, found that *Psorophora discolor* made up from 14 to 44 percent of the total specimens taken in light traps. Outside of the rice growing areas of these states and over most of its range it is considered an uncommon species.

During the summer of 1955, observations on the biology of *Psorophora discolor* were started near Cleveland, Mississippi, and continued during the summer of 1956 near Greenwood, Mississippi. These studies were made to determine the important breeding sites of this species, and to learn something of its larval associations, seasonal distribution, and habits.

In the Mississippi Delta area *Psorophora discolor* passes the winter in the egg stage. Eggs are deposited on moist soil in the fall and hatch when ground pools are flooded from the dry state in the spring. The larvae appear first in ground pools formed by precipitation, and later in rice fields and other breeding sites resulting from irrigation. Normally the mosquito populations would drop as the surface pools formed by precipitation dried up. However, the irrigation of crops starts in Mississippi at just about the time the first brood of *Psorophora discolor* completes its development. This makes available large areas of water highly suitable for additional mosquito breeding, and results in continued high populations.

In the vicinity of Cleveland, Mississippi, the principal breeding sites of *Psorophora discolor* were found to be shallow grassy ditches, irrigated rice fields, and surface pools in pastures. Small numbers of larvae were also found developing in irrigated cotton fields, sloughs, and roadside borrow pits. In 1956 in the vicinity of Greenwood, Mississippi, very similar conditions were noted. The typical breeding sites support dense stands of grass and are largely devoid of canopy shade.

The larval populations of *Psorophora discolor* reached a seasonal peak in 1955, during the week ending June 18. The highest populations occurred following considerable rainfall and at the beginning of the irrigation season. A second but less important peak occurred during the week ending July 9, and resulted almost entirely from breeding in irrigated rice fields and pastures.

Psorophora discolor was found most often in association with *Psorophora confinnis*, and *Anopheles quadrimaculatus* Say. It was collected occasionally with *Aedes vexans* Meigen, *Psorophora ciliata* (Fabricus), *Culex salinarius* Coquillett, *Culex erraticus* (Dyar and Knab), *Culex restuans* Theobald, and *Culex pipiens* Linn. In ditches and pastures *Psorophora discolor* was second to *Psorophora confinnis* in numbers, and was more abundant than *Anopheles quadrimaculatus*. In rice fields it was third in abundance, ranking behind *Psorophora confinnis* and *Anopheles quadrimaculatus*.

If disturbed, the larvae of *Psorophora discolor* immediately submerge to the bottoms of the pools or ditches and lie with their ventral sides up, each supported

on its air tube and stiff thoracic hairs. The length of time that a larva can remain submerged was timed with a stop watch. This time period ranged from 3 to 88 minutes, with an average of 44 minutes. In routine mosquito sampling this species is often missed because of its ability to remain submerged for long periods. To get an accurate sample it is necessary to scrape the dipper through the bottom debris, and then carefully examine the contents.

In practically every habitat studied a mixture of species was encountered. *Psorophora* larvae appeared shortly after flooding and no further hatching occurred unless there was another rise in water level. *Psorophora confinnis* was able to complete development to the pupal stage in approximately 6 days and the adults emerged in 8 days. The larvae of *Psorophora discolor* developed more slowly, requiring 10 or more days to reach the pupal stage. The broods of *Psorophora* were thus clearly defined, with most of the *Psorophora confinnis* adults having emerged before the *Psorophora discolor* larvae reached the pupal stage.

Irrigation is increasing yearly in the Mississippi Delta area, and with it the mosquito problem is becoming more acute. Emphasis should be given to elimination of habitats resulting from over-irrigation and poor drainage. Proper land preparation and leveling is now being done by many of the farmers and this practice should be encouraged. Measures to prevent the flooding of ditches should be utilized where needed, and drains should be provided for the removal of surplus water.

LITERATURE CITED

Mathis, W., C. Elmore, and **H. F. Schoof.** 1955. Further studies on the chemical control of rice field mosquitoes in Mississippi. Mosq. News 15(3): 148–153.

Diseases of Fruit Crops. *Harry Warren Anderson,* Ed. McGraw-Hill Book Company, Inc., New York. First Edition. 1956. vii+501 pp. $8.50.

The author, with his experience in research, teaching, and application in the field of fruit diseases, has adequately fulfilled the need for a book on this subject. The book is well organized and generally up to date. The introduction includes a general discussion on losses due to fruit diseases, causal agents, symptoms, and control. Many individual diseases are covered in the remaining 12 chapters, including diseases of pome and stone fruits, brambles, grapes, strawberries, gooseberries, currants, cranberries, and blueberries. Good illustrations of symptoms are used. The book is invaluable as a text in a course in fruit diseases; it is useful as a reference in many other courses, valuable in research in plant pathology and horticulture, and a good reference for orchardists.

C. C. Allison

Vertebrate Embryology. *Robert S. McEwen.* Henry Holt & Co., New York. Fourth Edition. 1957. xiii+701 pp. $6.50.

College instructors throughout the country engaged in the training of pre-professional studies in medicine and allied fields will be pleased to learn of the recently published fourth edition of Professor Robert S. McEwen's "Vertebrate Embryology," long regarded as a standard textbook in the field. The new edition takes advantage of modern printing and binding skills in producing an attractive volume. Furthermore, while this thoroughly tested book retains its fundamental characteristics, it has been brought up to date by incorporating principles of developmental mechanics and the more firmly established results of experimental embryology as developed in recent years.

This new edition, with its modern look, should ensure McEwen's book's continued use and the place of high regard which it has enjoyed since its first publication more than three decades ago.

John W. Price

POLYEMBRYONY IN *HIEROCHLOE ODORATA* (L.) BEAUV.[1]

KNUT J. NORSTOG

Biology Department, Wittenberg College, Springfield, Ohio

Polyembryony, though far from a rare phenomenon in the angiosperms, is intimately and regularly associated with the reproductive processes in only a few taxa. Among the grasses some species of *Poa* (Nielson 1946a, 1946b), *Tripsacum dactyloides* and *T. lanceolatum* (Farquharson, 1955) are remarkable prolific in their production of supernumerary embryos. Other grasses produce double embryos much less frequently. For example, Webber (1940) in a review of polyembryony, cites twinning frequencies of less than one percent for wheat, oats, rice and rye. Thus, although sporadic formation of more than one embryo per ovule may be encountered among members of *Gramineae*, it is noteworthy when an additional species can be numbered with those few in which the phenomenon frequently occurs.

Several years ago, in the course of an investigation of embryogenesis in some Michigan grasses, it was found that a number of the grains of Seneca grass, *Hierochloe odorata* (L.) Beauv., contained multiple embryos. Recently, in the spring of 1956, collections were begun in two areas of Michigan and examinations of this material confirmed and amplified the earlier findings.

MATERIAL AND METHODS

Hierochloe odorata is an early spring flowering grass of wet meadows and shorelines. Anthesis normally takes place in early May in southern Michigan. Accordingly, collections were made during the second week of May along the Huron River near Ann Arbor, and in June along the shores of Douglas Lake in Cheboygan County. Douglas Lake is near the tip of the lower peninsula of Michigan, where the flowering period of *Hierochloe* is about two weeks later than in Ann Arbor. Although the spring of 1956 was late, the collecting was not started early enough to obtain many specimens showing cytological events leading up to embryo sac formation.

Spikelets were removed without otherwise disturbing the plants, which nowhere were abundant. Some of the specimens were killed and fixed on the spot using a CRAF formula, and later sectioned at thicknesses of 12 to 25μ. The serial sections were stained either in iron-alum hematoxylin or crystal violet counterstained with fast green. Other material was brought into the laboratory for dissection and study. A number of excised embryos were placed on White's (White 1943) nutrient agar at this time, and eventually whole grains were planted in the greenhouse or placed on wet filter paper in order to study germination and seedling development.

RESULTS

As the examination of material from the two areas progressed it became apparent, first of all, that many of the florets in each inflorescence contained abortive caryopses. Only 29 percent of a sample of 235 central florets were fully developed (the spikelet of *Hierochloe* consists of two lateral, staminate florets and a central, perfect floret). The failures occurred at various stages. Many pistils had not enlarged at all, while others appeared to be full grown but were vesicular and col-

[1]A contribution from the University of Michigan Biological Station. This investigation was initially aided by a grant from the Faculty Research Fund of Wittenberg College and continued under a grant from the National Science Foundation.

lapsed when they were pricked. Many more had been attacked and destroyed by thrips, which were quite numerous.

A total of 398 seemingly normal grains were dissected and it was found that 25 percent contained double embryos. The frequencies of this occurrence, in terms of percent, were the same in the Huron River and the Douglas Lake samples. Twelve percent of the total contained no embryos at all although their endosperms looked normal, and two grains contained triplet embryos. Microscopic examination of serial sections of a number of these grains confirmed the observations. In two caryopses the embryos were mere undifferentiated balls of callus. These data are presented in table 1.

The serial sections also showed a number of multiple embryos (fig. 5 and 6). In these, as in the dissected grains, the embryos usually appeared side by side with their coleorhizae in contact at the tips and the cotyledons so closely joined that it was difficult to separate them visually. About half of the twins were of equal size; the remainder consisted of well formed but disproportionate pairs. In most cases the twin embryos were smaller than single embryos.

TABLE 1

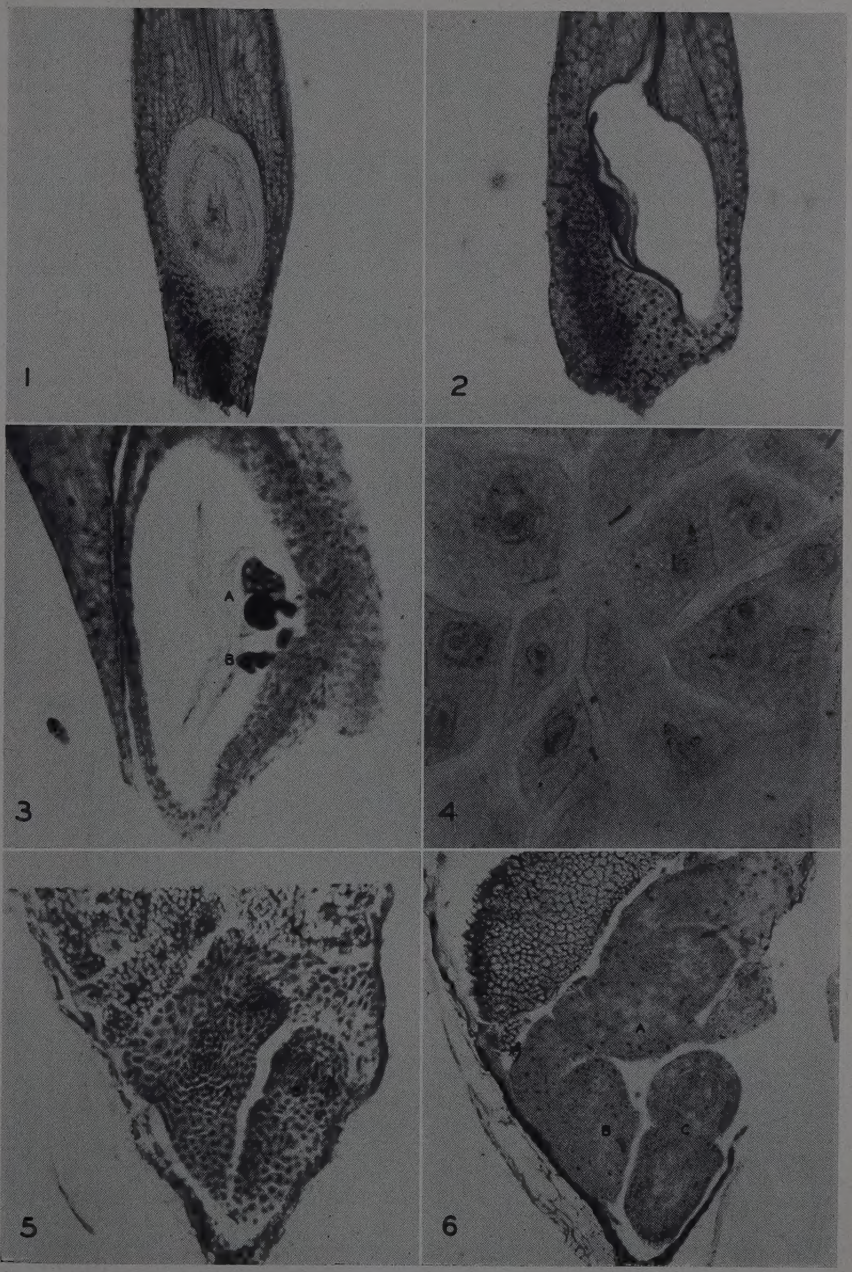
Embryo development in Hierochloe odorata

Locality	Number of grains containing: 3 embryos	2 embryos	1 embryo	0 embryos	callused embryos
Huron River	0	30	86	3	2
Douglas Lake	2	68	178	29	0
Both areas	2	98	264	32	2

Viability of twin embryos.—Ten sets of excised twin embryos were cultured on nutrient agar. Both members of four of these sets grew into small seedlings, while only one embryo in each of the remaining pairs grew. In October, five months after harvesting, a series of germination tests was begun. In the first experiment, 50 grains were planted in individual pots and placed in the greenhouse. Three months later only one of these had germinated and at present (April) no further activity has been noted. Another set of 25 grains was sterilized in 10 percent *Clorox* and placed on nutrient agar. After several weeks had elapsed without evidence of germination, several embryos were excised and replaced on the agar. These, including a pair of twin embryos, immediately grew into small seedlings. The remaining grains in this sample were scarified and replaced on agar, whereupon they also germinated without further delay. A third set, of 100 scarified grains, was then placed on wet filter paper. Germination was slow, but in 30 days 47 had germinated. Only one of these produced twin seedlings (fig. 7). A further trial, this time with selected grains known to contain twin embryos, produced 14 single seedlings and three twin seedlings when cultured on wet filter paper. The remainder of the 23 caryopses did not germinate.

EXPLANATION OF FIGURES PLATE I

1. Caryopsis demonstrating failure in megasporogenesis.
2. Ovule failure following the formation of the embryo sac.
3. Twin embryo sacs. The antipodals of each sac, A and B, are shown.
4. Endosperm cells with lobed and multiple nuclei.
5. Twin embryos, A and B.
6. Triple Embryos, A, B and C.


1
2
A
B
3
4
5
A
B
C
6

Embryogenesis.—It is impossible at this time to present a complete report on the formation of multiple embryos in Seneca grass. The embryo sacs, of which 15 were observed, lacked synergids. Two polar nuclei and three large, deeply stained antipodal cells, together with the egg, constituted the most nearly complete embryo sacs observed in this material.

Only one ovule was found in which two embryo sacs (fig. 3) clearly were present, although care was taken that this phenomenon, which has been associated with polyembryony in *Poa pratensis* (Anderson, 1927), should not escape notice if it occurred in *Hierochloe*. Evidences of fertilization were observed in but two instances.

Abortive ovules were commonplace. In many, the abortions had taken place during or soon after megasporogenesis, and the cells of the nucellus and integument in these cases had become enlarged and rather vacuolate (fig. 1). Most of the other failures had occurred after the megagametophytes had formed (fig. 2); in several, a small proembryo was present without endosperm.

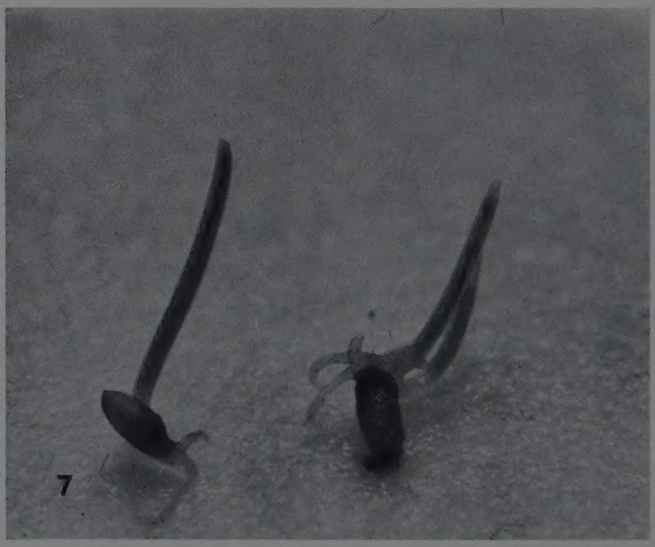


FIGURE 7. Single and twin seedlings of *Hierochloe odorata*. Cultured on wet filter paper.

A single ovule, shown in figure 8, contained both an egg and a proembryo. The latter, because of its location, appeared to be of nucellar origin. Origin from a synergid probably may be dismissed, since the synergids were not present at the time of embryo formation. In this specimen it was also observed that the endosperm had failed to develop. Several ovules, one of which may be seen in figure 9, displayed endosperm in the free nuclear stage accompanied by apparently unfertilized eggs. This state seems to be a potential antecedent of the condition in which certain ripened grains lack embryos altogether. In any event, the free nuclear stage was followed by the formation of endosperm cells which contained large lobulate nuclei (fig. 4). Sometimes several nuclei were present in a single cell. These details later were obscured by masses of starch grains.

Although a number of proembryos have been seen in the sectioned material, only in ripe or nearly ripened ovules have multiple embryos thus far been observed. Further observations will be required to ascertain the stage at which the twin embryos appear, as well as the manner of their development.

DISCUSSION

The significance of polyembryony in *Hierochloe odorata*, aside from its frequency, is that it suggests a different origin from that reported for most other grasses. Nielson (1946a, 1946b), citing from the considerable accumulation of literature pertaining to polyembryony and apomixis in the genus, *Poa*, tells of such varied origins as the parallel embryogenesis from multiple embryo sacs, from an egg and a synergid or an egg and a nucellar cell, these being further complicated by different sorts of apomictic developments. The nucellar origin of extra embryos in *Poa*

FIGURE 8. A proembryo (EM) and unfertilized egg occupying one ovule. Remaining antipodal cell at A.

FIGURE 9. Ovule containing endosperm in free nuclear stage and an egg; oi-outer integument, ii-inner integument, E-endosperm nucleus, A-antipodal nuclei.

pratensis is the view held by Nishimura (1922), who suggests that several embryos per ovule may be initiated either by nucellar budding or from outgrowths of the suspensor. He also correlates polyembryony with attacks of thrips, although Anderson (1927) later contends that there is no relationship between such infestation and polyembryony. She attributes the formation of multiple embryos to the development of more than one embryo sac. Farquharson (1955) suggests that polyembryony in *Tripsacum dactyloides* may be due to the apomictic development of a synergid together with the egg. In these cases, cited above, the endosperm may develop without fertilization of the polar nuclei, although pollination appears to be necessary in the process.

The twin embryos in *Hierochloe* might be schizogenous in origin. Since proembryos were observed to occur singly while the older, twin embryos were extremely

closely associated, a reasonable conclusion is that they were formed as a result of longitudinal separation of a single proembryonic mass.

The number of grains which were altogether lacking in embryos is another unique feature of this grass and may by inference indicate the occurrence of apomixis.

Although the twin embryos are capable of growing into seedlings *in vitro*, they normally do not both germinate *in vivo*. The difference in growth is probably nutritional rather than genetic, since in many instances one of the embryos appears to be located less advantageously with respect to the endosperm.

SUMMARY

1. Plants of *Heirochloe odorata* from each of two widely separated Michigan locations produced twin embryos in 25 percent of the grains examined. **2**. The multiple embryos may have been formed as a result of division of single embryos as evidenced by their orientation and the absence of twin proembryos. **3**. The germination of grains was slow even after scarification. This was equally true of those containing normal embryos and those which held twins. The latter grew much better when excised and grown on nutrient agar, where both members of several pairs flourished. Otherwise, usually only one of a pair germinated. **4**. Other anomalies observed were triple embryos and the complete absence of embryos. Twelve percent of the grains dissected in this study lacked embryos, although they contained normal endosperm.

REFERENCES

Anderson, A. M. 1927. Development of the female gametophyte and caryopsis of *Poa pratensis* and *Poa compressa*. Jour. Ag. Res. 34: 1001–1018.

Farquharson, L. I. 1955. Apomixis and ployembryony in *Tripsacum dactyloides*. Amer. Jour. Bot. 42: 737–743.

Nielson, E. L. 1946a. Breeding behavior and chromosome numbers in progenies from twin and triplet plants of *Poa pratensis*. Bot. Gaz. 108: 26–40.

———. 1946b. The origin of multiple macrogametophytes in *Poa pratensis*. Bot. Gaz. 108: 41–50.

Nishimura, M. 1922. On the germination and the polyembryony of *Poa pratensis*, L. Bot. Mag. Tokyo 36: 47–55.

Webber, J. M. 1940. Polyembryony. Bot. Rev. 6: 575–598.

White, P. R. 1943. Plant Tissue Culture. Ronald Press, N. Y.

Conserving Natural Resources. *Shirley W. Allen.* McGraw-Hill Book Co., Inc. New York. 1955. ix+347 pp. $5.50.

Professor Allen presents the three essentials of a sound conservation program as "use with minimum waste, increasing productivity where possible and desirable, and seeing to it that natural resources are equitably distributed now and hereafter." He cites need for unity in presenting various aspects of the uses of natural resources, combining consideration of the replaceable with the nonrenewable resources, and pointing out some of the social and economic aspects of conservation practices for college students.

The textbook is divided into seven chapters, each covering one kind of resource. These subjects, land, water, forests, wild animals, minerals, and human powers, are all treated well, with those concerning minerals and the human powers exceptionally well done. Most wildlife technicians now believe that changes in abundance of particular species are associated with changes in environment, and with successions leading to increased abundance of replacement forms (of more or less value for man). This viewpoint has been overlooked by Professor Allen in his presentation of instances of depletion by over-exploitation.

THOMAS H. LANGLOIS